PALÆONTOGRAPHICAL SOCIETY.
VOL. LXVI.

BRITISH GRAPTOLITES.

PART IX.

PAGES 415—486; PLATES XLII—XLIX.

THE CAMBRIAN TRILOBITES.

PART IV.

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THE CRETACEOUS LAMELLIBRANCHIA.

VOL. II, PART IX.

INCLUDING TITLE-PAGE AND INDEX.

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THE FOSSIL MALACOSTRACOUS CRUSTACEA.

TITLE-PAGE AND INDEX.

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PALÆONTOGRAPHICAL SOCIETY.

VOLUME LXVI.

CONTAINING

1. BRITISH GRAPTOLITES. Part IX. By Miss Elles and Miss Wood. Edited by Prof. Lapworth. Eight Plates.

2. THE CAMBRIAN TRILOBITES. Part IV. By Mr. P. Lake. Four Plates.

3. THE CRETACEOUS LAMELLIBRANCHIA. Vol. II, Part IX. With Title-page and Index. By Mr. H. Woods. Eight Plates, and twelve whole-page Text-figures.

4. THE FOSSIL MALACOSTRACOUS CRUSTACEA. By Prof. T. Bell. Title-page and Index.

ISSUED FOR 1912.

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AGENTS FOR THE SOCIETY
DULAU AND CO., LTD., 37, SOHO SQUARE, W.

FEBRUARY, 1913.

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Most of the *back volumes* are in stock. Monographs or parts of Monographs already published can be obtained, apart from the annual volumes, from Messrs. DULAU AND CO., LTD., 37, Soho Square, London, W., who will forward a complete price list on application.

Members desirous of forwarding the objects of the Society can be provided with plates and circulars for distribution on application to the Secretary, Dr. A. SMITH WOODWARD, British Museum (Nat. Hist.), South Kensington, London, S.W.

The following Monographs are in course of publication:

The Graptolites, by Prof. Lapworth, Miss Elles, and Miss Wood.

The Cambrian Trilobites, by Mr. Philip Lake.

The Crag Mollusca, by Mr. F. W. Harmer.

The Palæoniscid Fishes of the Carboniferous Formation, and the Fishes of the Old Red Sandstone, by Dr. R. H. Traquair.

The Pleistocene Mammalia, by Prof. S. H. Reynolds.

Geology
QE 701
.P29

ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1912,

WITH

LIST

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY PUBLISHED.

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ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR ENDING 31ST DECEMBER, 1911.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE, 22ND MARCH, 1912.

DR. HENRY WOODWARD, F.R.S., PRESIDENT,

IN THE CHAIR.

THE Council, in presenting their Sixty-fifth Annual Report, have the satisfaction to record good progress in the Society's work. The volume for 1911 includes the final instalments of the monographs of "English Chalk Fishes," by Dr. A. S. Woodward, and of "The Pleistocene Mammalia," Vol. II, by Professor S. H. Reynolds; while the issue of the title-page and index for the "British Fossil Sponges," Vol. I, by Dr. G. J. Hinde, now permits the binding of that work. Instalments of the "Carboniferous Ganoid Fishes," by Dr. R. H. Traquair, and of "Cretaceous Lamellibranchia," by Mr. H. Woods, also nearly complete two monographs which have been in course of preparation for many years. The total number of plates is less than usual; but this deficiency is more than compensated by the very large series of text-figures of Cretaceous Lamellibranchia, which seem to be more useful than plates for the illustration of the specimens of *Inoceramus* described.

Owing to unforeseen delay in the receipt of one of the contributions, the volume for 1911 was not ready for distribution until the end of February, 1912, and the expense of binding and some of the printing could not be included in the balance-sheet for the year. At the same time it must be noted that similar delay

in the completion of the volume for 1910 caused corresponding charges for this previous volume to be carried forward to the beginning of the year 1911. The total expenditure shown in the balance-sheet is therefore approximately equal to the cost of the volume just distributed to subscribers. This expenditure remains within the income, thanks to the generosity of the Carnegie Trust for the Universities of Scotland, who have given to the Society the five plates illustrating Carboniferous Fishes.

During the past few years the Council have sold to subscribers at a reduced rate a large amount of surplus back stock, for the storage of which they could no longer find room. The demand for this stock having ceased, and the number of copies yet remaining, especially of the older volumes, being either imperfect or unsaleable, the Council have been compelled to send a considerable amount of surplus stock to the paper-makers for destruction. They have, however, taken special care to keep an ample supply of all the monographs which are in constant demand, and have also retained all the complete copies of the volumes from No. 50 onwards.

The thanks of the Society are due to the Council of the Geological Society for permission both to store the stock of back volumes, and to hold the Council Meetings and the Annual General Meeting in their apartments.

In conclusion, it is proposed that the retiring members of Council be Mr. William Hill, Mr. Hopkinson, Mr. Woods, and Mr. Young; that the new members be Miss Crosfield, Mr. George Barrow, Mr. H. R. Knipe, and Prof. W. W. Watts; that the President be Dr. Henry Woodward; the Treasurer, Dr. G. J. Hinde; and the Secretary, Dr. A. Smith Woodward.

Annexed is the Balance-sheet.

THE PALÆONTOGRAPHICAL SOCIETY IN ACCOUNT WITH DR. GEORGE J. HINDE, F.R.S., TREASURER.

Cr. *From January 1st, 1911, to December 31st, 1911.* *Dr.*

		£	s.	d.	£	s.	d.
Balance from last Account					422	11	2
Members' Subscriptions—1909–1910	101	106	1	0			
„ „ 1911	265	278	5	0			
„ „ 1912–1915	11	11	11	0			
	377				395	17	0
Carriage paid by Members					1	17	0
Sales of back stock to Members					48	13	6
Sales by Messrs. Dulau & Co., Ltd.					56	16	7
Sale of waste paper					4	4	0
Repaid Income Tax (1 year)					0	17	6
Dividends on £500 Natal 3 per cent. Stock (less income tax)					14	2	6
Interest on Deposit					9	5	11
					£954	5	2

	£	s.	d.	£	s.	d.
Letterpress printing, Vols. LXIV, LXV	127	9	3			
Paper	23	8	3			
				150	17	6
Drawing text-figures and making blocks	89	2	5			
Drawing plates	86	15	0			
Collotype and lithographic printing	61	14	2			
				237	11	7
Binding (Vol. LXIV)				41	8	4
Packing and distribution, Vol. LXIV				15	7	0
Secretary's honorarium				52	10	0
Postage and stationery				4	9	11
Notices and Cards				1	1	3
Arranging Stock and preparing Stock Book				3	10	0
Fire Insurance				0	15	0
Petty charges				1	7	4
Balance at Bank—Current Account	45	7	3			
Deposit Account	400	0	0			
				445	7	3
				£954	5	2

We have examined the above account, compared it with the vouchers, and find it to be correct; we have also seen the receipt for £500 Natal 3 per cent. Consolidated Stock.

GEORGE BARROW,
HENRY DEWEY,
H. R. KNIPE,
ALFRED W. OKE. } Auditors.

March 8th, 1912.

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CORRECTED TO 1st DECEMBER, 1912.

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* Members are requested to inform the Secretary of any errors or omissions in this list, and of any delay in the transmission of the Yearly Volumes.

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„ II.	Issued July, 1849, for the year 1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell (pp. 1—76, pls. i—xxviii, viii A, x A, xiii A, xvi A, xviii A, xix*, xix B, xix C, xix D). The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards (pp. 1—56, pls. i—ix).
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[1] The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils'; the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

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[1] From 1865 onwards the Volumes are issued in two forms of binding: first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

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- Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan (pp. 1—24, pls. i—vii), with an Index to the Tertiary and Secondary Species.
- The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright (pp. 161—184, pls. xl—xliv).
- The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward (pp. 121—180, pls. xxi—xxx).
- The Fossil Trigoniæ, No. I, by Dr. Lycett (pp. 1—52, pls. i—ix).

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- The Fossil Echinodermata, Cretaceous, Vol. I, Part VI, by Dr. Wright (pp. 185—224, pls. xlv—lii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part I (Tertiary and Cretaceous), by Mr. Davidson (pp. 1—72, pls. i—viii).
- Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood (pp. 99—231, pls. viii—xi, and add. plate).
- Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen (pp. 1—18, pls. i, ii).
- Supplement to the Reptilia of the Wealden (Hylæochampsa), No. VI, by Prof. Owen (pp. 1—7).
- The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen (pp. 1—14, pls. i, ii).

„ XXVIII. Issued July, 1874, for the Year 1874

- The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson (pp. i—v, 1—232, pls. i—xvi).
- The Carboniferous Entomostraca, Part I (Cypridinidæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady (pp. 1—56, pls. i—v).
- The Fossil Trigoniæ, No. II, by Dr. Lycett (pp. 53—92, pls. x—xix).

„ XXIX. Issued Dec. 1875, for the Year 1875

- The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney (pp. 97—147, pls. xix—xxiv).
- The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright (pp. 225—264, pls. liii—lxii).
- The Fossil Trigoniæ, No. III, by Dr. Lycett (pp. 93—148, pls. xx—xxvii).
- The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen (pp. 15—94, pls. iii—xxii).

„ XXX. Issued Dec., 1876, for the Year 1876

- The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady (pp. 1—166, pls. i—xii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson (pp. 73—144, pls. ix—xvi).
- Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen (pp. 1—7, pls. i—vi).

„ XXXI. Issued Feb., 1877, for the Year 1877

- Supplement to the Eocene Mollusca (Bivalves), by Mr S. V. Wood, 2 plates.
- The Fossil Trigoniæ, No. IV, by Dr. Lycett (pp. 149—204, pls. xxviii—xl).
- The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood (pp. 331—361, pl. xxxiv).
- The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair (pp. 1—60, pls. i—vii).
- The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen (pp. 95—97, pls. xxiii, xxiv).
- The Fossil Elephants, Part I (E. antiquus), by Prof. Leith Adams (pp. 1—68, pls. i—v).

„ XXXII. Issued Mar., 1878, for the Year 1878

- The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright (pp. 265—300, pls. lxii A, lxiii—lxix).
- Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright (pp. 469—481).
- The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward (pp. 181—263, pls. xxxi—xxxvi, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson (pp. 145—242, pls. xvii—xxix).
- The Lias Ammonites, Part I, by Dr. Wright (pp. 1—48, pls. i—viii).
- The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall (pp. 1—32, pls. i, i A, ii—v).
- Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen (pp. 1—15, pls. i—vi).
- The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins (pp. i—xxxviii).

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Vol. XXXIII. Issued May, 1879, for the Year 1879

- The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 1—38, pls. i—v).
- Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood (pp. i, ii, 1—58, pls. i—vi, and title-page).
- The Fossil Trigoniæ, No. V, by Dr. Lycett (pp. 205—245, pl. xli, and title-page).
- The Lias Ammonites, Part II, by Dr. Wright (pp. 49—164, pls. ix—xviii).
- Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen (pp. 1—19, pls. i—iv).
- The Fossil Elephants, Part II (E. primigenius), by Prof. Leith Adams (pp. 69—146, pls. vi—xv).

„ XXXIV. Issued May, 1880, for the year 1880

- The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 39—58, pls. vi—xi).
- The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright (pp. 155—203, pls. xix—xxi, pp. i—iv, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson (pp. 243—316, pls. xxx—xxxvii).
- The Lias Ammonites, Part III, by Dr. Wright (pp. 165—264, pls. xix—xl).
- The Reptilia of the London Clay, Vol. II, Part I (Chelone), by Prof. Owen (pp. 1—4, pls. i, ii).

„ XXXV. Issued May, 1881, for the Year 1881

- The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright (pp. 301—324, pls. lxx—lxxv).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson (pp. 317—368, pls. xxxviii—xlii).
- The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett (pp. 1—4).
- The Lias Ammonites, Part IV, by Dr. Wright (pp. 265—328, pls. xxii A, xxii B, xli—xlviii).
- The Reptilia of the Liassic Formations, Part III, by Prof. Owen (pp. 83—134, pls. xxi—xxxiii, and title-page).
- The Fossil Elephants, Part III (E. primigenius and E. meridionalis), by Prof. Leith Adams (pp. 147—265, pls. xvi—xxviii, and title-page).

„ XXXVI. Issued June, 1882, for the Year 1882

- The Eocene Flora, Vol. I, Part III, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 59—86, pls. xii, xiii, and title-page).
- Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood (pp. 1—24, pl. i).
- The Fossil Echinodermata, Cret., Vol. I, Part X, by Dr. Wright (pp. 325—371, pls. lxxvi—lxxx, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part V, by Dr. Davidson (pp. 369—383, and title-page).
- Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson (pp. 1—134, pls. i—vii).
- The Lias Ammonites, Part V, by Dr. Wright (pp. 329—400, pls. xlix—lii, lii A, liii—lxix).

„ XXXVII. Issued Oct., 1883, for the Year 1883

- The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner (pp. 1—60, pls. i—ix).
- The Trilobites of the Silurian, Devonian, &c., Formations, Part V, by the late Mr. J. W. Salter (pp. 215—224, and title-page).
- The Carboniferous Trilobites, Part I, by Dr. H. Woodward (pp. 1—38, pls. i—vi).
- Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson (pp. 135—242, pls. viii—xvii).
- The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett (pp. 5—19, pls. i—iv, and title-page).
- The Lias Ammonites, Part VI, by Dr. Wright (pp. 401—440, pls. lxx—lxxvii).

„ XXXVIII. Issued Dec., 1884, for the Year 1884

- The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner (pp. 61—90, pls. x—xx).
- The Carboniferous Entomostraca, Part I, No. 2, by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady (pp. i—iii, 57—92, pls. vi, vii, and title-page).
- The Carboniferous Trilobites, Part II, by Dr. H. Woodward (pp. 39—86, pls. vii—x, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. V, Part III, by Dr. Davidson (pp. 243—476, pls. xviii—xxi, and title-page).
- The Lias Ammonites, Part VII, by Dr. Wright (pp. 441—480, pls. lxxviii—lxxxvii).

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,, XLII. Issued Mar., 1889, for the Year 1888	The Stromatoporoids, Part II, by Prof. Alleyne Nicholson (pp. 131—158, pls. xii—xix). The Tertiary Entomostraca (Supplement), by Prof. T. Rupert Jones and Mr. C. D. Sherborn (pp. 1—55, pls. i—iii). The Jurassic Gasteropoda, Part I, No. 3, by Mr. W. H. Hudleston (pp. 137—192, pls. vii—xi). The Inferior Oolite Ammonites, Part III, by Mr. S. S. Buckman (pp. 57—144, pls. xv, xxiii A). The Devonian Fauna of the South of England, Part I, by the Rev. G. F. Whidborne (pp. i, ii, 1—46, pls. i—iv). Title-pages and Prefaces to the Monographs on the Reptilia of the Wealden and Purbeck (Supplements), Kimmeridge Clay, and Mesozoic Formations, and on the Cetacea of the Red Crag.
,, XLIII. Issued Mar., 1890, for the Year 1889	The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde (pp. i—viii, 1—70, pls. i—iv). The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston (pp. 193—224, pls. xii—xvi). The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman (pp. 145—224, pls. xxiv—xxxvi). The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne (pp. 47—154, pls. v—viii, viii A, ix—xv).
,, XLIV. Issued Apr., 1891, for the Year 1890	The Stromatoporoids, Part III, by Prof. Alleyne Nicholson (pp. 159—202, pls. xx—xxv). The Fossil Echinodermata, Cretaceous, Vol. II, Part I (Asteroidea), by Mr. W. Percy Sladen (pp. 1—28, pls. i—viii). The Inferior Oolite Ammonites, Part V, by Mr. S. S. Buckman (pp. 225—256, pls. xxxvii—xliv). The Devonian Fauna of the South of England, Part III, by the Rev. G. F. Whidborne (pp. 155—250, pls. xvi—xxiv). Title-pages to the Supplement to the Fossil Corals, by Prof. Duncan.
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,, XLVIII. Issued Nov., 1894, for the Year 1894	The Jurassic Gasteropoda, Part I, No. 7, by Mr. W. H. Hudleston (pp. 325—390, pls. xxvii—xxxii). Carbonicola, Anthracomya, and Naiadites, Part I, by Dr. W. Hind (pp. 1—80, pls. i—xi). The Inferior Oolite Ammonites, Part IX, by Mr. S. S. Buckman (pp. 377—456, pls. xciii—ciii). The Fishes of the Old Red Sandstone, Part II, No. 1, by Dr. R. H. Traquair (pp. 63—90, pls. xv—xviii).
,, XLIX. Issued Oct., 1895, for the Year 1895	The Crag Foraminifera, Part II, by Prof. T. R. Jones (pp. 73—210, pls. v—vii). The Jurassic Gasteropoda, Part I, No. 8, by Mr. W. H. Hudleston (pp. 391—444, pls. xxxiii—xl). Carbonicola, Anthracomya, and Naiadites, Part II, by Dr. W. Hind (pp. 81—170, pls. xii—xx). The Devonian Fauna of the South of England, Vol. II, Part IV, by the Rev. G. F. Whidborne (pp. 161—212, pls. xviii—xxiv).
,, L. Issued Oct., 1896, for the Year 1896	The Crag Foraminifera, Part III, by Prof. T. R. Jones (pp. 211—314). The Jurassic Gasteropoda, Part I, No. 9, by Mr. W. H. Hudleston (pp. 445—514, pls. xli—xliv, and title-page). Carbonicola, Anthracomya, and Naiadites, Part III, by Dr. W. Hind (pp. 171—182, pl. xxi, and title-page). The Carboniferous Lamellibranchiata, Part I, by Dr. W. Hind (pp. 1—80, pls. i, ii). The Devonian Fauna of the South of England, Vol. III, Part I, by the Rev. G. F. Whidborne (pp. 1—112, pls. i—xvi).
,, LI. Issued Dec., 1897, for the Year 1897	The Crag Foraminifera, Part IV, by Prof. T. R. Jones (pp. vii—xv, 315—402, and title-page). The Carboniferous Lamellibranchiata, Part II, by Dr. W. Hind (pp. 81—208, pls. iii—xv). The Carboniferous Cephalopoda of Ireland, Part I, by Dr. A. H. Foord (pp. 1—22, pls. i—vii). The Devonian Fauna of the South of England, Vol. III, Part II, by the Rev. G. F. Whidborne (pp. 113—178, pls. xvii—xxi).
,, LII. Issued Dec., 1898, for the Year 1898	The Palæozoic Phyllopoda, Part III, by Prof. T. R. Jones and Dr. Woodward (pp. 125—176, pls. xviii—xxv). The Carboniferous Lamellibranchiata, Part III, by Dr. W. Hind (pp. 209—276, pls. xvi—xxv). The Inferior Oolite Ammonites, Part X, by Mr. S. S. Buckman (pp. i—xxxii, Suppl. pls. i—iv). The Carboniferous Cephalopoda of Ireland, Part II, by Dr. A. H. Foord (pp. 23—48, pls. viii—xvii). The Devonian Fauna of the South of England, Vol. III, Part III, by the Rev. G. F. Whidborne (pp. 179—236, pls. xxii—xxxviii).

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„ LV.	Issued Dec., 1901, for the Year 1901	The Cretaceous Lamellibranchia, Part III, by Mr. H. Woods (pp. 113—144, pls. xx—xxvi). The Carboniferous Lamellibranchiata, Vol. II, Part I, by Dr. W. Hind (pp. 1—34, pls. i—vi), Title-page and Index for Vol. I. The Carboniferous Cephalopoda of Ireland, Part IV, by Dr. A. H. Foord (pp. 127—146, pls. xxxiii—xxxix). British Graptolites, Part I, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. 1—54, pls. i—iv). Ganoid Fishes of British Carboniferous Formations—Part I, Palæoniscidæ, No. 2, by Dr. Ramsay H. Traquair (pp. 61—87, pls. viii—xviii).
„ LVI.	Issued Dec., 1902, for the Year 1902	The Cave Hyæna, by Prof. S. H. Reynolds (pp. 1—25, pls. i—xiv). The Fishes of the English Chalk, Part I, by Dr. A. Smith Woodward (pp. 1—56, pls. i—xiii). The Cretaceous Lamellibranchia, Part IV, by Mr. H. Woods (pp. 145—196, pls. xxvii—xxxviii). British Graptolites, Part I, No. 2, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. i—xxviii, 55—94, pls. v—xiii).
„ LVII.	Issued Dec., 1903, for the Year 1903	The Fishes of the English Chalk, Part II, by Dr. A. Smith Woodward (pp. 57—96, pls. xiv—xx). The Cretaceous Lamellibranchia, Part V, by Mr. H. Woods (pp. i—xliii, 197—232, pls. xxxix—xlii), Title-page and Index for Vol. I. The Carboniferous Lamellibranchiata, Vol. II, Part II, by Dr. W. Hind (pp. 35—124, pls. vii—xxi). The Carboniferous Cephalopoda of Ireland, Part V, by Dr. A. H. Foord (pp. 147—234, pls. xl—xlix), Title-page and Index. The Lower Palæozoic Trilobites of Girvan, Part I, by Mr. F. R. Cowper Reed (pp. 1—48, pls. i—vi). British Graptolites, Part III, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. xxix—lii, 103—134, pls. xiv—xix).
„ LVIII.	Issued Dec., 1904, for the Year 1904	The Fishes of the Old Red Sandstone, Part II, No. 2, by Dr. R. H. Traquair (pp. 91—118, pls. xix—xxvi). The Cretaceous Lamellibranchia, Vol. II, Part I, by Mr. H. Woods (pp. 1—56, pls. i—vii). The Carboniferous Lamellibranchiata, Vol. II, Part III, by Dr. W. Hind (pp. 125—216, pls. xxii—xxv). The Inferior Oolite Ammonites, Part XII, by Mr. S. S. Buckman (pp. lxv—clxviii, pls. xv—xix). The Lower Palæozoic Trilobites of Girvan, Part II, by Mr. F. R. Cowper Reed (pp. 49—96, pls. vii—xiii). British Graptolites, Part IV, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. liii—lxxii, 135—180, pls. xx—xxv).

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A MONOGRAPH

OF

BRITISH GRAPTOLITES.

BY

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PART IX.

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Distally the polypary may appear to be nearly straight, but it commonly shows curvature to some slight extent; in the proximal portion the curvature is, as a rule, distinctly dorsal.

The mature thecæ are similar in form to those of *M. vomerinus*, but possibly with rather less torsion of the thecal axes. The apparent narrowing of the thecæ in the apertural region may be real, but it is at any rate exaggerated by the torsion, and may be entirely induced by it. Occasionally, as the result of compression, the twisted apertural region shows a tendency to isolation, and an effect almost of retroversion is produced; it is evident, however, from the study of specimens preserved in different ways that this appearance is produced entirely by the conditions of preservation.

Affinities.—The slender flexed character of the polypary serves to distinguish *Monog. crenularis* from all allied species other than *M. griestoniensis*, from which it may be readily separated by its lesser curvature and greater breadth.

Horizon and Locality.—Llandovery (Birkhill Shales), zone of *M. convolutus*.

S. Scotland.—Dobb's Linn, etc. *Central Wales:* R. Twymyn, above Llanbrynmair.

Associates, etc.—*Monog. crenularis* occurs in S. Scotland associated with *Cephalog. cometa*, *Petalog. folium*, *Glyptog. tamariscus* var. *incertus*, *Orthog. bellulus*, *Monog. lobiferus*, *M. convolutus*, *M. Clingani*, *M. denticulatus*, etc. It is not a very common fossil.

Collections.—Geological Survey of Scotland and Lapworth.

Monograptus galaensis, Lapworth. Plate XLII, figs. 1 *a*—*c*.

1876. *Monograptus galaensis,* Lapworth, Geol. Mag. [2], vol. iii, p. 356, pl. xii, figs. 5 *a*—*d*.

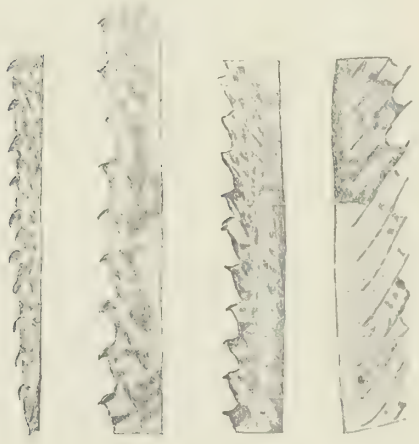
Polypary several cm. in length, straight or very slightly flexed, widening fairly rapidly from an initial breadth of ·6 mm. to a maximum of about 2 mm. Thecæ ten to nine in 10 mm., with slight ogee curvature, and contracting somewhat in the apertural region; those of the proximal portion with a tendency to retroversion, those of the distal portion everted, with the apertural margin thickened and produced into a distinct denticle or tag. Overlap one-third to two-thirds of the total thecal length.

Description.—The polypary is quite slender in the proximal portion, which is slightly inflexed in the immediate neighbourhood of the sicula; it, however, attains its maximum breadth fairly quickly and is then uniformly wide for the greater part of its extent. The maximum width of 2 mm. is, however, rarely attained, a breadth of 1·5 mm. being of commoner occurrence.

The sicula has a length of 1 mm., and the thecæ of the proximal portion are relatively broad with a decided tendency towards retroversion of the apertural

region; this tendency disappears entirely in the distal portion, where the thecæ are conspicuously everted and the apertural margin produced into a distinct denticle. The overlap increases from one-third proximally to two thirds in the more mature portion of the polypary.

FIGS. 281 *a*—*d*.—*Monograptus galaensis*, Lapworth.



a *b* *c* *d*

a. Proximal end, showing sicula. Fragment on same slab as Pl. XLII, fig. 1 *b*.
b. Distal thecæ. Fragment on same slab as above.
c. Distal thecæ in low relief. Meigle Quarry, S. Scotland; Gala Beds. Coll. Lapworth.
d. Fragment showing the long walls of the distal thecæ. Meigle Quarry, S. Scotland; Gala Beds. Coll. Lapworth.

Affinities.—*Monog. galaensis* has characters which connect it with some of the members of the group of *M. priodon*, especially such forms as *M. Halli*, but the plane of the apertural margin is never really retroverted, even in the proximal region, so that *M. galaensis* seems connected more closely with the members of the group of *M. vomerinus*, and from these its more slender form and the characters of the proximal thecæ should be sufficient to render its separation fairly easy.

Horizon and Localities. — Gala-Tarannon Beds (zones of *M. turriculatus* and *M. crispus*.)

S. Scotland.—Meigle Quarry; Quarry near Old Cambus, Cockburnspath, 5 miles N. by E. of Lauder; Buckholm; Darnick; Glendearg; Wooplaw; Tushielaw, etc.

Wales.—Forge Corner, Conway.

Collections.—Geological Survey of Scotland, Lapworth, and the Authors.

GROUP IV.

Monograpti in which the mature thecæ are tubes with the apertural region more or less isolate and retroverted.

In the *Monograpti* included in this group, the ventral walls of the thecæ show ogee curvature, and the isolation and retroversion of the apertural region give to the terminal portion of the theca the form of a more or less distinct *hook*. This hook, however, is never bent back upon itself, in other words the axis of the theca in the course of its growth never bends through an angle exceeding 180°. The proportion of the total breadth of the polypary occupied by the characteristic hook varies considerably in different species. In some, the proportion of the breadth may be as much as two-thirds (*M. priodon*), or it may be the merest fraction (*M. Halli*). There is also considerable variation in the proportion of the theca involved in the retroversion of the apertural region.

There is commonly, if not invariably, some torsion of the thecal axis. As a rule the torsion is in a *positive* direction, so that viewed from one side (the

obverse) the thecal apertures more or less face the observer; while from the other side (the reverse) no aperture, or in some cases no apertural termination, is visible at all. The result of this torsion, after compression, is the production of very different "*appearances*," which appearances seem to have been often misunderstood, and by some observers have even been regarded as of specific value.

Many of the difficulties encountered in the endeavour to interpret correctly the different appearances presented by the polypary in Groups IV and V of the *Monograpti* will be obviated if it be borne in mind that the entire polypary in *Monograptus* may theoretically be regarded as the left-hand vertical half of a polypary of *Diplograptus* presented in its typical or obverse aspect, the right-hand half being absent or suppressed.

Consistently with this nomenclature, that special view of the *outer surface* of the polypary in *Monograptus*, in which the axis of the polypary lies towards the right hand of the observer and the apertural margins of the thecæ towards the left, may be regarded as the *obverse aspect*, and that in which these conditions are reversed as the *reverse aspect*.

Many of the more striking features available for specific distinction in the aspect were those which were dependent upon the varying extent to which the individual thecæ in the course of their growth had become curved by flexure or bending, and simultaneously turned sideways by torsion. The ultimate amount of bending that each thecal axis underwent, measured in degrees from the line of the axis of the polypary, constituted naturally its original angle of inclination or *thecal angle*; and the ultimate amount of twisting sideways, when measured in degrees, constituted its original *torsional angle*.

During and subsequent to fossilisation, however, the varying accidents of the mode and degree of preservation, the amount and direction of compression and flattening, the occasional splitting of the fossil and its containing rock laminæ during extraction, etc., have each brought about a definite effect, either singly or in combination.

The ultimate result of all the foregoing is shown in that sum of appearances which is exhibited in the actual *view* of the fossil as now seen by the palæontologist and carefully represented upon his figures. The polypary may itself lie normally in the left-hand (obverse) or right-hand (reverse) *view*, but the correct interpretation of all the detailed *appearances* presented is often a matter of extreme difficulty.

The graptolites included in the present group may be further divided into sections and sub-sections according as to whether the thecæ are uniform or bi-form, and according to the kind of curvature of the polypary. It is obvious, however, that a classification on such a basis is largely a matter of convenience.

A. With *uniform* thecæ—

1. With approximately straight polypary. Type *Monograptus priodon*. *M. pandus*, *M. Marri*, *M. cultellus*, *M. riccartonensis*, *M. Flemingii*,

var. *primus*, var. *compactus*, *M. uncinatus* var. *orbatus*, var. *micropoma*, *M. irfonensis*.

2. With curved polypary.

(*a*) The polypary has *dorsi-ventral* curvature. Type, *Monograptus flexilis*.

M. acus, *M. distans*, *M. undulatus*, *M. scanicus*, *M. crinitus*, *M. Jaekeli*, *M. gemmatus*.

(*b*) The polypary has *spiral* curvature. Type, *Monograptus turriculatus*. *M. discus*, *M. tortilis* (?).

B. With *bi-form* thecæ—

1. With approximately straight polpary. Type, *Monograptus Sedgwickii*. *M. Halli*, *M. M'Coyi*.

2. With curved polypary.

(*a*) The polypary has *spiral* curvature. *Monograptus testis*, var. *inornatus* (?).

IV. A. 1: *Monograpti* in which the thecæ are uniform and the polypary approximately straight.

Monograptus priodon (Bronn.). Plate XLII, figs. 2 *a*—*e*.

1835. *Lomatoceras priodon*, Bronn, Lethea Geognostica, I, p. 56, pl. i, fig. 13.
1850. *Graptolithus priodon*, Barrande, Grapt. de Bohême, p. 38, pl. i, figs. 3—9, 14.
1851. *Graptolithus priodon*, Suess, Böhm. Graptolithen, p. 25, pl. viii, fig. 5.
1852. *Monograptus priodon*, Geinitz, Die Graptolithen, p. 43, pl. iii, figs. 20—24, 26, 28—30.
1868. *Graptolites priodon*, Nicholson, Grapt. Coniston Flags, Quart. Journ. Geol. Soc., vol. xxiv, p. 540, pl. xx, fig. 6.
1871. *Monograptus priodon*, Richter, Aus dem Thüring. Schiefergeb., iv, Zeitschr. d. deutsch. geol. Gesell., vol. xxiii, pl. v, fig. 1.
1872. *Graptolites priodon*, Nicholson, Monogr. Brit. Grapt., p. 102, fig. 47.
1875. *Monograptus priodon*, Richter, Aus dem Thüring. Schiefergeb., v, Zeitschr. d. deutsch. geol. Gesell., vol. xxvii, p. 269, pl. viii, fig. 7.
1876. *Monograptus priodon*, Lapworth, Scottish Monograptidæ, Geol. Mag., [2], vol. iii, p. 21.
1877. *Monograptus priodon*, Lapworth, Grapt. Co. Down, Proc. Belfast Nat. Field Club, p. 129, pl. v, fig. 24.
1879. *Monograptus priodon*, Linnarsson, Gotl. Grapt., K. Svensk. Vet.-Akad. Förhandl., p. 24, pl. x, figs. 1—12.
1881. *Monograptus priodon*, Törnquist, Om Några Grapt. från Dalarne, Geol. Fören. i. Stockholm Förhandl., vol. v, p. 737, pl. xvii, fig. 3.
1881. *Monograptus priodon*, Linnarsson, Grapt. med *M. turriculatus* vid Klubbuden, Geol. Fören. i Stockholm Förhandl., vol. v, p. 509, pl. xxii, figs. 3, 4.
1883. *Monograptus priodon*, Tullberg, Skånes Graptoliter, ii, p. 22, pl. ii, fig. 24.
1890. *Monograptus priodon*, Holm, Gotl. Grapt., Bihang till K. Svensk. Vet.-Akad. Handl., vol. xvi, p. 14, fig. 28.
1890. *Monograptus priodon*, Geinitz, Grapt. Dresden Museum, p. 17, pl. A, fig. 16.
1892. *Monograptus priodon*, Törnquist, Siljansområd. Grapt., ii, p. 13, pl. 1, figs. 22—27.

Polypary of great length, straight and rigid, widening gradually and persistently from an initial breadth of ·75 mm. to a maximum of 3 mm. Sicula conspicuous. Thecæ thirteen to eight in 10 mm., showing pronounced ogee curvature, narrowing towards the apertural region, with considerable torsion of the axis and with fully two-thirds of the total thecal length involved in the prominent hook, which occupies fully one-half of the total breadth of the polypary. Overlap one-third to two-thirds the total length.

Description.—The polypary of *Monog. priodon* must have attained a very great length, since fragments 10—12 cm. in extent are of fairly frequent occurrence. Those in beds of Gala-Tarannon age are usually shorter than those from the Wenlock Shales, rarely attain a breadth exceeding 2·5 mm., and commonly average about 2 mm. only. The specimens which come from the Wenlock Shales are, as a rule, longer and wider, measuring fully 3 mm. in breadth.

FIGS. 282 *a*, *b*.—*Monograptus priodon* (Bronn).

a *b*

a. Proximal end, showing part of sicula; preserved in limestone, in full relief. Builth (?); Wenlock Beds. Geol. Survey of England and Wales.

b. Smaller specimen, in partial relief, showing complete sicula. Penwhapple Glen, Girvan; Gala beds. Coll. Lapworth.

The proximal end is relatively slender, not exceeding 1 mm. in width; and the dorsal wall of the polypary is continuously straight, though the position of the sicula sometimes causes an appearance of slight retroflexion; the sicula itself has a length of 1·5 mm. and reaches nearly to the top of th. 2.

The thecæ in the proximal portion of the polypary are all fairly small and measure thirteen in 10 mm.; in the distal portion, however, they are larger, and measure eight in the same unit of length. Proximally about one-half of the theca only is involved in the hook, which occupies about one-half of the total breadth of the polypary; but distally fully two-thirds is involved, though the hook occupies but two-fifths of the total breadth; it is clear therefore that in the maturer part of the polypary the hook portion is relatively longer. The plane of the thecal aperture in all cases faces the proximal end of the polypary, making approximately an angle of 135° with the axis of the polypary itself. In some specimens there is an appearance of expansion near the apertural margin, but this is not noticeable in others. Perner has separated such forms as distinct varieties, but the apparent expansions seem to us to be consequent upon the torsion of the thecal axis in the apertural region, so that after compression the actual aperture is in one aspect (the obverse) facing the observer and in the other turned away. An occasional appearance of a slight obliquity in the apertural margin would seem to be due to the same cause. The thecæ as a whole present two extreme but common views according to whether the obverse or reverse aspect is presented. In the reverse aspect (fig. 282 *c*) the

mode of origin of the successive thecæ, and hence the amount of overlap, is clearly visible, the thecæ appearing as more or less sacculate tubes diminishing towards their apertural regions, which are reflexed into a robust hook. In the obverse aspect, however, the place of origin of the thecæ is not seen, and hence the thecæ appear to be shorter and broader, in contact only, and with narrower reflexed apertural regions; thus in this aspect extra prominence is given to the upper wall of each theca.

Figs. 282 *c, d.*—*Monograptus priodon* (Bronn).

c *d*

c. Distal thecæ (reverse aspect) on same slab as Fig. 282 *a*. Apertures of thecæ partially embedded in the limestone.

d. Distal thecæ in low relief, showing apertural margins, and short interthecal walls, obverse aspect. Tarannon River; Talerddig Beds. Coll. Wood.

Affinities.—*Monog. priodon* resembles *M. pandus* and *M. Marri* more than any of the other members of the group, so closely indeed as to have led to great confusion. From *M. pandus*, which it also resembles in general form and size, *M. priodon* differs in the characters of the thecæ, which have (1) a relatively longer hook, (2) are inclined at a lower angle, (3) have more overlap, and (4) are more closely set in the proximal region than those of *M. pandus*. In *M. Marri* the polypary is more slender than in *M. priodon*, and there is also relatively less isolation and retroversion of the apertural region of the thecæ.

Horizon and Localities.—Gala-Tarannon to Lower Wenlock Shales (zone of *M. crispus* to zone of *M. riccartonensis*).

S. Scotland.—Grieston; Tushielaw; Selkirk; Galashiels; Riccarton, etc. *Lake District.*—Long Sleddale; Nanny Lane, Troutbeck; W. of Bluecaster Side, Sedbergh, etc. Harter Fell; Wandale Hill; Bluecaster; Middle and Near Gills, Cautley. *Wales.*—Pencerrig, Builth; Trecoed, Builth; Walcot Quarry, Chirbury; Penarth Quarry, Carrog; Tarannon River; Talerddig, etc.

Associates, etc.—*Monog. priodon* is one of the commonest and one of the best known of all Graptolites. It seems to make its first appearance in the Tarannon Shales in the zone of *M. crispus*, and occurs there in association with *M. crispus*, *M. discus*, and *M. Marri*; it is, however, at that horizon subordinate in numerical importance to *M. Marri* and *M. pandus*. It increases in numbers in the higher beds until in the zone of *Cyrtog. Murchisoni* at the base of the Wenlock Shales, it is one of the commonest Graptolites as well as one of the most characteristic of that horizon. Its vertical range extends also into the succeeding zone of *M. riccartonensis*, but thereafter its place is taken by *M. Flemingii*.

Collections.—British Museum (Natural History), Sedgwick Museum, Belfast Natural History Museum, Geological Survey of England and Wales, and of Scotland, Lapworth, Fearnsides, and the Authors.

Monograptus pandus (Lapworth). Plate XLII, figs. 3 *a—d*.

1877. *Monograptus lobiferus* var. *pandus*, Lapworth, Grapt. Co. Down, Proc. Belfast Nat. Field Club, p. 129, pl. vi, figs. 3 *a—c*.

1897. *Monograptus densus*, Perner, Grapt. de Bohême, pt. iii, p. 22, pl. xi, figs. 12, 13.

Polypary several cm. in length, approximately straight; fairly robust even at the proximal end and widening steadily till a maximum breadth of 2·5 mm. is attained. Thecæ nine to ten in 10 mm., of the general type of *M. priodon*, but shorter, and set so that the hooks, involving one-third only of the thecæ, are often nearly in contact, and only occupy one-fifth of the total breadth of the polypary.

Description.—*Monog. pandus* is often of considerable size, and in some of the longer specimens its breadth seems slightly to exceed that given for the Bohemian form *M. densus*, with which, however, it agrees so closely in other particulars that it is practically certain that the two are specifically identical.

Fig. 283.—*Monograptus pandus* (Lapworth).

Distal fragment. Enlargement of part of Pl. XLII, fig. 3 *b*.

The most prominent character of *M. pandus* is undoubtedly the presence of the short thecæ set at so high an angle that the relatively short hooks are nearly in contact at their extremities. This feature is most marked in the distal thecæ, those of the proximal end approximating more closely to the thecæ of *M. Marri*; indeed the whole proximal end approaches that of *M. Marri* in general characters, but is stiffer and slightly more robust, while the sicula has a greater length (1·7 mm.).

Affinities.—*Monog. pandus* is a form which, in many respects, is intermediate between *M. priodon* and *M. Marri*. From *M. priodon* it differs chiefly in the relatively shorter and less conspicuous hook, and from *M. Marri* in these characters and also in the fact that it is always more robust.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. turriculatus* to zone of *M. griestoniensis*).

Lake District: Swindale; Browgill; Rawthey Bridge, Sedbergh. *N. Wales:* Forge Corner, Conway. *Ireland:* Tieveshilly, Co. Down.

Associates, etc.—*Monog. pandus* appears to be confined to rocks of Gala-Tarannon age. It occurs in the zone of *M. turriculatus* associated with the zone fossil, *M. nodifer*, *M. runcinatus*, *M. dextrorsus*, etc.; in the zone of *M. crispus* with *M. crispus*, *M. exiguus*, *M. discus* and *M. Marri*, and in the zone of *M. griestoniensis* with *M. discus* and the zone fossil.

Collections.—Sedgwick Museum, Lapworth, and the Authors.

Monograptus Marri, Perner. Plate XLII, figs. 4 *a—d*.

1897. *Monograptus Marri*, Perner, Grapt. de Bohême, pt. iii *a*, p. 21, pl. ii, figs. 5, 6, 10, 11, text-figs. 23—25.

Polypary narrow, not exceeding 10 cm. in length, more or less straight and rigid, widening rapidly from an initial breadth of ·5 mm. to a maximum of 1·8 mm. which is then maintained. Sicula conspicuous. Thecæ ten in 10 mm., of the general type of *M. priodon* throughout, but with rather less of the theca involved in the hook, which occupies slightly more than half the breadth of the polypary.

Description.—The polypary, while as a general rule stiff in appearance, shows sometimes a tendency to flexure which may occasionally be considerable. British examples seem to exceed the typical Bohemian form in length, though among them the maximum breadth of 1·8 mm. is but rarely attained. Individuals with an average breadth of about 1·5 mm. are of far commoner occurrence. The normal breadth is attained fairly rapidly in the proximal portion of the polypary, so that the width is approximately uniform for the greater part of its extent.

FIGS. 284 *a* and *b*.—*Monograptus Marri*, Perner.

a *b*

a. Proximal end in low relief, showing sicula. Enlargement of part of Pl. XLII, fig. 4 *a*.
b. Distal thecæ in partial and low relief. Enlargement of part of Pl. XLII, fig. 4 *c*.

The sicula has a length of 1·2 mm. reaching just half way between th. 1 and th. 2.

The thecæ number ten in 10 mm. throughout, from the proximal to the distal extremity of the polypary. Nearly two-thirds of the total thecal length is involved in the hook, which occupies rather more than one-half of the width of polypary. The interthecal line between any two thecæ is short, and is as a rule quite inconspicuous, in marked contrast to what obtains in *M. priodon*. As in *M. priodon*, there is a considerable amount of torsion of the thecal axis, so that in one aspect (the reverse) there is often a deceptive appearance of tapering of the theca towards its apertural margin. Sometimes, too, the effect of compression on the twisted theca makes it appear as if the thecal axis had curved through a greater angle than 180°. Not only so, but in some examples the thecal angle appears to be slightly under or slightly over this, and it can, therefore, hardly be doubted that this effect is one due merely to compression and is a deceptive *appearance*.

Affinities.—*Monog. Marri* is closely related to both *M. priodon* and to *M. pandus*. It differs from *M. priodon* in the dimensions of the polypary as a whole, being both shorter and narrower; as regards the thecæ, though of the same general type as

those of the above-mentioned species, they are shorter and broader and have relatively larger apertural hooks; and from *M. pandus* it differs in the same particulars.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. turriculatus* to zone of *M. griestoniensis*).

S. Scotland.—Buckholmside, Galashiels; Ladhope Burn; Thornylee; Blythe Water, Lauder; Caddonfoot. *Wales:* Llanystwmdwy, near Criccieth; Conway; Tarannon River, and other localities near Llanbrynmair. *Lake District:* Skelgill; Pull Beck.

Associates, etc.—*Monog. Marri* is a common fossil in the Tarannon beds of Wales and their equivalents in S. Scotland.

In the zone of *M. turriculatus* it occurs somewhat sparingly associated with *M. turriculatus*, *M. nudus*, *M. nodifer*, *M. Becki* and *M. dextrorsus*; in the zone of *M. crispus*, it occurs in considerable abundance, with *M. crispus*, and *M. discus*, and it is also found with *M. griestoniensis* in the zone above.

Collections.—Geological Survey of Scotland, Fearnsides, Jones, and the Authors.

Monograptus cultellus, Törnquist. Plate XLII, figs. 9 *a*, *b*.

1881. *Monograptus cultellus*, Törnquist, Några Grapt. från Dalarne, Geol. Fören. i Stockh. Förhandl., vol. v, p. 434, pl. xvii, figs. 1 *a*, *b*.
1883. *Monograptus cultellus*, Tullberg, Skånes Grapt., II, p. 30, pl. i, figs. 26, 27.
1892. *Monograptus cultellus*, Törnquist, Siljansområdets Grapt., ii, p. 17, pl. i, figs. 32, 35.

Polypary straight with incurved proximal extremity, very short and relatively broad, about 6 mm. only in length; widening very rapidly from ·5 mm. to a maximum breadth of 1 mm. Sicula conspicuous. Thecæ twenty in 10 mm. similar to those of *M. discus*.

Description.—The small size of the polypary and the slight incurving of the proximal end are highly characteristic of this species. The polypary shows a remarkably rapid increase in breadth, widening conspicuously in the five or six thecæ which make up the total length of the polypary itself.

The sicula measures 1·5 mm. in length, reaching to the top of th. 2.

FIG. 285.—*Monograptus cultellus*, Tullberg.

Small specimen, showing sicula. Enlargement of Pl. XLII, fig. 9 *a*.

Affinities.—The form of the polypary suggests that of a short *M. colonus*, but the thecæ are precisely similar to those of *M. discus*. The combination of these two characteristics renders this species easy of identification.

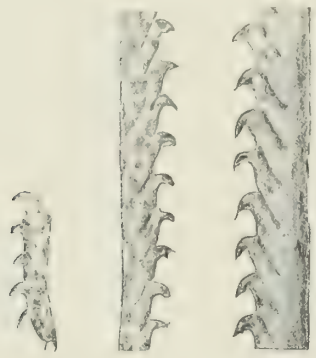
Horizon and Localities.—Lower Wenlock Shales (basal beds).
Wales: Road between Llanbrynmair and Talerddig; Tarannon River?
Collection.—Wood.

Monograptus riccartonensis, Lapworth. Plate XLII, figs. 8 *a—e.*

1876. *Monograptus riccartonensis,* Lapworth, Geol. Mag. [2], vol. iii, p. 355, pl. xiii, figs. 2 *a—e.*
1877. *Monograptus riccartonensis,* Lapworth, Proc. Belfast Nat. Field Club, pl. v, fig. 23.
1880. *Monograptus riccartonensis,* Lapworth, Ann. Mag. Nat. Hist. [5], vol. v, p. 155, pl. iv, fig. 8 *c.*
1883. *Monograptus riccartonensis,* Tullberg, Skånes Grapt., p. 23, pl. ii, figs. 26, 27.

Polypary 7 cm. or more in length, straight or with slight dorsal flexure, having an approximately uniform breadth of 1·5 mm.; proximal end slightly reflexed. Sicula conspicuous. Thecæ ten to eight in 10 mm., of the general type of *M. priodon*, but smaller with fully one-half involved in the hook, which, however, occupies only one-quarter of the total breadth. Overlap one-third to one-half the total length.

FIGS. 286 *a—c.*—*Monograptus riccartonensis,* Lapworth.



a *b* *c*

a. Small proximal fragment, showing sicula. On same slab as Pl. XLII, fig. 8 *b*.
b. Thecæ not far from proximal end. On same slab as Pl. XLII, fig. 8 *b*.
c. Distal thecæ in relief. Penwhapple Glen, Girvan; Wenlock Beds. Coll. Lapworth.

Description.—The polypary has commonly a peculiar limp and "broken-backed" appearance, but some specimens may appear comparatively straight (Pl. XLII, fig. 8 *e*). It widens from an initial breadth of ·5 mm. (exclusive of the sicula) to 1·5 mm. within the first 3 cm. of length; the breadth is then as a rule maintained for the remainder of its length, though occasionally specimens whose maximum breadth is 2 mm. are met with in some localities.

The sicula is long, measuring 1·6 mm. in length and reaching nearly to the level of th. 2.

The thecæ throughout call to mind those of the proximal part of *M. Sedgwickii* when the thecal spine in that species is not well seen.

Affinities.—*Monog. riccartonensis* may be regarded as a narrow limp form intermediate in some respects between *M. priodon* and *M. Sedgwickii*. It differs from *M. priodon* in its narrower limper habit and less conspicuously hooked thecæ; and from *M. Sedgwickii* in being narrower, in the absence of spines on the thecæ, and in the greater retroversion of the apertural region in the more distal thecæ.

Horizon and Localities.—Wenlock Shales (Riccarton Beds), zone of *Cyrtog. Murchisoni* and zone of *M. riccartonensis.*

S. Scotland: Riccarton; Balmae Shore, Kirkcudbright; Penwhapple Glen; Hindhope; Edgerston; Dalton, etc. *Wales:* Penarth Quarry, Carrog; Large

Quarry, Glyn Ceiriog; Caer Drewyn, Rhayader Road, near Builth Road Station; Castle Crab, near Builth Road; Grove Cottages, Builth Road; River Ithon, N.E. of Newbridge. *Shropshire:* Walcot Quarry, near Chirbury. *Lake District:* Middle and Near Gill, Cautley; River Rawthey; Wandale Hill, etc.

Associates, etc.—*Monog. riccartonensis* makes its first appearance towards the top of the zone of *Cyrtog. Murchisoni*, where it is as a rule rather short and is associated with the zone fossil, *M. priodon*, *M. vomerinus*, etc. It is, however, rather rare at this horizon but comes in abundantly in the rocks above, where it is characteristically long and limp, and is associated with the earliest forms of *M. dubius*; other associates at this higher horizon are *M. priodon*, *M. vomerinus* and *M. capillaceus*, but as *M. riccartonensis* is often found hereabout to the exclusion of every other form it is taken by Elles and others as the index fossil of the zone.

Collections.—Geological Survey of Scotland, Sedgwick Museum, Lapworth, and the Authors.

Monograptus Flemingii (Salter). Plate XLII, figs. 5 *a—d*.

1852. *Graptolithus Flemingii*, Salter, Quart. Journ. Geol. Soc., vol. viii, p. 390, pl. xxi, figs. 5 *a*, *b*, 6, 7 *a*, *b*.

1876. *Monograptus Flemingii*, Lapworth, Geol. Mag. [2], vol. iii, p. 504, pl. xx, fig. 8.

1883. *Monograptus Flemingii*, Tullberg, Skånes Grapt., Svensk. Geol. Undersökn., ser. C, no. 55, p. 23, pl. ii, fig. 25.

1900. *Monograptus Flemingii*, var. β and var. δ, Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 402, figs. 11 and 14.

Polypary straight, or slightly flexed, attaining a length of 17 cm. or more, with recurved proximal portion, widening gradually to a maximum breadth of 2·5 mm., which is then maintained. Sicula relatively small. Thecæ fourteen to nine in 10 mm., with abruptly narrowing apertural region; aperture commonly furnished below with a short claw or spine, giving the appearance of a beak or rostrum, the whole beak occupying from one-fifth to one-third the total breadth of the polypary.

Description.—The polypary is of considerable length and is usually found in a fragmentary state. These fragments, if short, may appear approximately straight, but if fairly long, show the flexure characteristic of the species.

The sicula has a length of about 1·6 mm. and shares in the reflexure of the whole proximal end; it is furnished with a short stiff virgella.

The thecæ vary somewhat in different parts of the polypary; usually about one-half of the thecal length is involved in the beak-like hook, which proximally is so small that it occupies only one-fifth of the breadth of the polypary; this amount, however, increases up to one-third in the distal portion. The thecæ are set far more closely in the proximal than in the distal portion.

Figs. 287 *a—d.*—*Monograptus Flemingii* (Salter).

a. Proximal end, showing sicula. Enlargement of part of Pl. XLII, fig. 5 *a*.
b. Thecæ in proximal region, in low relief, showing apertural margin. Enlargement of part of Pl. XLII, fig. 5 *b*.
c. More distal thecæ on same specimen, showing various appearances presented by the thecæ.
d. Fragment preserved in relief; part of apertural margins embedded in the limestone. Tunnel under Wren's Nest, Dudley; Wenlock Limestone. Holcroft Collection, Birmingham University.

Affinities.—*Monog. Flemingii* is undoubtedly very closely related to *M. priodon* and *M. riccartonensis*. From *M. priodon* it differs in respect of its form by being more flexed, and in respect of its thecæ by having a more robust apertural region with a rapid diminution in breadth—in other words by the shorter *beak*-like rather than *hook*-like termination of the thecæ. From *M. riccartonensis* it differs similarly as respects its thecæ, but agrees with it in the flexure of its polypary.

Horizon and Localities.—Upper Wenlock Shales (especially the zone of *Cyrtog. Lundgreni*).

Welsh Borders: River Irfon, Builth; Builth Bridge; Aberedw Hill, near Builth; Ackley Lane, Long Mountain, etc. *Scotland:* Riccarton Burn, etc. *Worcestershire:* Wren's Nest, Dudley.

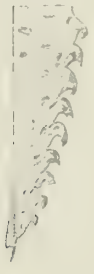
Associates, etc.—*Monog. Flemingii* is a common fossil at the top of the zone of *Cyrtog. Lundgreni*, where it occurs with *M. dubius* and the zone fossil; but it makes its first appearance in the zone of *Cyrtog. rigidus* below.

Collections.—Birmingham University, Lapworth, and the Authors.

Var. **primus,** nom. nov. Plate XLII, figs. 6 *a—d.*

1900. *Monograptus Flemingii*, var. *a*, Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 402, fig. 11.

Fig. 288.—*Monograptus Flemingii* var. *primus*, nov.



Proximal end, showing sicula. Enlargement of part of Pl. XLII, fig. 6 *b*.

In adddition to the typical species there is a variety which is in some respects intermediate in character between it and var. *compactus*. In this the polypary varies from 1—4 cm. in length, widens rapidly to a maximum breadth of 2·5 mm., is practically straight in the proximal portion, and the thecæ vary in number from fourteen to eight in 10 mm. It is a straighter and shorter form widening more rapidly than the typical one, individuals about 2 cm. in length being of commonest occurrence.

Horizon and Localities.—Wenlock Shales (zones of *Cyrtog. symmetricus* and *C. rigidus*).

Welsh Borders: Dulas Brook, near Pencerrig, Builth; Nant Prophwyd, near Builth; Llwynrhedith Quarry, Long Mountain. *Lake District:* Middle and Near Gills, Cautley; Bluecaster Gill; River Rawthey; Wandale Hill, etc.

Collections.—Misses Watney and Welch, the Authors.

Var. **compactus** nom. nov. Plate XLII, figs. 7 *a—d.*

1900. *Monograptus Flemingii*, var. γ, Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 403, fig. 13.

In addition to the forms described above, there also occurs in the Upper Wenlock Shales a very small and compact variety. This rarely exceeds 1·5 cm. in length but has an average breadth of 3 mm.; the thecæ also are very closely set, numbering sixteen to eighteen in 10 mm.

Fig. 289.—*Monograptus Flemingii* var. *compactus*, nov.

Complete specimen, showing sicula. Enlargement of Pl. XLII, fig. 7 *a*.

Horizon and Localities.—Wenlock Shales (zone of *Cyrtog. Lundgreni*, especially the lower part).

Welsh Border: River Irfon, near Builth; Ackley Lane, Long Mountain; Llwynrhedith Quarry, Long Mountain. *Lake District:* Near Gill, Cautley; Middle Gill, Cautley; West Wandale, Cautley, etc.

Collections.—Watney and Welch, the Authors.

Monograptus uncinatus var. **orbatus,** Wood. Plate XLIII, figs. 1 *a—d.*

1900. *Monograptus uncinatus* var. *orbatus*, Wood, Quart. Journ. Geol. Soc., vol. lvi, p. 476, pl. xxv, figs. 23 *A* and *B* and text-figs. 20 *a* and *b*.

Polypary relatively robust and somewhat flexed; from 2 to 5 cm. in length, increasing gradually in breadth from ·7 mm. to a maximum of about 2 mm. Sicula conspicuous. Thecæ twelve to nine in 10 mm.; of the general *M. Flemingii* sub-type but with rather less of the theca involved in a more claw-like hook. Overlap about one-half the total length.

Description.—The polypary has a rather limp or broken-backed appearance after the manner of *M. riccartonensis*, though otherwise the shape more resembles that of *M. colonus*.

The sicula has a length of 1·6 mm. and reaches to the level of the top of th. 2; its outer wall continues the line of the polypary much as is the case in *M.*

colonus. Indeed, the whole proximal portion of the polypary resembles that of an *M. colonus* in which the proximal type of theca persists for a greater distance than usual.

Figs. 290 *a* and *b*.—*Monograptus uncinatus* var. *orbatus*, Wood.

a. Proximal end, showing part of sicula. Trefnant-Middletown Brook, Long Mountain; Lower Ludlow Shales. Coll. Wood.

b. Distal thecæ, showing different appearances presented after compression. Enlargement of part of Pl. XLIII, fig. 1 *c*.

In the distal portion of *M. uncinatus* var. *orbatus*, however, as the result of compression, a peculiar appearance is seen, due to the combined effect of greater torsion of the theca and its more distinct claw-like or spine termination in the apertural region. Such an appearance is shown in fig. 290 *b*, and also in var. *micropoma*, fig. 291 *a*.

Affinities.—The combination of a *colonus*-like shape of the polypary with a general *Flemingii*-like type of thecæ is characteristic of this form, which seems to be the British representative of the Swedish *M. uncinatus*. From the variety *micropoma*, the only graptolite to which the form under description approaches closely both in the form and the characters of the thecæ, it differs in being wider, in having more thecæ in the same unit of length, and a rather more conspicuous beak.

Horizon and Localities.—Lower Ludlow Shales (zone of *M. Nilssoni*).

Welsh Borders: Trefnant-Middletown Brook, Long Mountain. *Worcestershire:* Wren's Nest, Dudley.

Associates, etc.—*Monog. uncinatus* var. *orbatus* is a rather rare fossil in the Lower Ludlow Shales, where it occurs in the zone of *M. Nilssoni* with the following characteristic assemblage: *M. bohemicus*, *M. Nilssoni*, *M. vulgaris* and *M. varians*.

Collections.—Dr. Fraser, Wood.

Var. **micropoma** (Jaekel). Plate XLIII, figs. 2 *a*—*c*.

1889. *Pomatograptus micropoma*, Jaekel, Zeitschr. d. deutsch. geol. Gesell., vol. xli, pl. xxix, figs. 4—6.

1900. *Monograptus uncinatus* var. *micropoma*, Wood, Quart. Journ. Geol. Soc., vol. lvi, p. 477, pl. xxv, figs. 24 *A* and *B*, text-figs. 21 *a* and *b*.

In addition to the variety described above, there occurs somewhat rarely in Britain another closely allied form which it seems best to regard as another variety of *M. uncinatus*. This is Jaekel's *Pomatog. micropoma*, which differs from var. *orbatus* in being rather straighter, in having a maximum breadth of 1·3 mm., and in having

Figs. 291 *a* and *b*.—*Monograptus uncinatus* var. *micropoma* (Jaekel).

a *b*

a. Proximal end, showing sicula. Figured Quart. Journ. Geol. Soc., vol. lvi, p. 478, fig. 21 *a*. Stormer Hall, Leintwardine; Lower Ludlow Shales. Coll. Wood.

b. Distal thecæ. Figured Quart. Journ. Geol. Soc., vol. lvi, p. 478, fig. 21 *b*. Stormer Hall, Leintwardine; Lower Ludlow Shales. Coll. Wood.

more distant thecæ (ten to nine in 10 mm.); the beak of the apertural region is also less conspicuous.

Horizon and Localities.—Lower Ludlow Shales (zone of *M. Nilssoni* and zone *of M. scanicus*).

Shropshire: Elton Lane, Ludlow; Stormer Hall, Leintwardine; Lower Winnington, Long Mountain; Garbett's Hall, Long Mountain.

Associates, etc.—Var. *micropoma* occurs chiefly in the zone of *M. Nilssoni* associated with *M. bohemicus*, *M. Nilssoni*, *M. varians*, var. *pumilus*, *M. dubius* and *M. chimæra* var *Salweyi*. It also occurs in the zone of *M. scanicus*.

Collection.—Wood.

Monograptus irfonensis, Elles. Plate XLIII, fig. 3.

1900. *Monograptus irfonensis*, Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 407, fig. 19.

Polypary very slender, approximately straight, 20 cm. or more in length, widening slowly to a maximum breadth of 1 mm. Thecæ eight to nine in 10 mm., of the general type of those of *M. priodon*, with about one-half of the thecal length involved in the hook, which occupies about one-third of the breadth of the polypary.

Fig. 292.—*Monograptus irfonensis*, Elles.

Thecæ preserved as low cast. Enlargement of part of Pl. XLIII, fig. 3.

Description.—The polypary is exceedingly long and slender, widening very slowly from a small sicula about 1 mm. in length to a maximum breadth of about 1 mm.

The thecæ show the characteristic ogee curvature and hook-like apertural region of the *M. priodon* type, but the whole theca is as it were more drawn out and the isolation and retroversion of the apertural region is less in proportion.

Affinities.—*Monog. irfonensis* presents a certain amount of resemblance to *M. scanicus*, but may be distinguished by its straighter polypary, more definite ogee curvature of the thecæ, and more conspicuous thecal hooks.

Horizon and Localities.—Wenlock Shales (zone of *Cyrtog. Lundgreni*).

Wales: Left bank of R. Irfon, N. of Irfon Bridge, Builth. *Shropshire:* Trewern Brook, near Middleton. *Lake District:* Harter Fell.

Associates, etc.—*Monog. irfonensis* occurs in the zone of *Cyrtog. Lundgreni*, associated with *C. Lundgreni*, and *M. Flemingii* var. *compactus;* it is a rare species.

Collections.—Watney and Welch, Elles.

IV. A. 2. (*a*) : *Monograpti* in which the thecæ are uniform and the polypary has dorsi-ventral curvature.

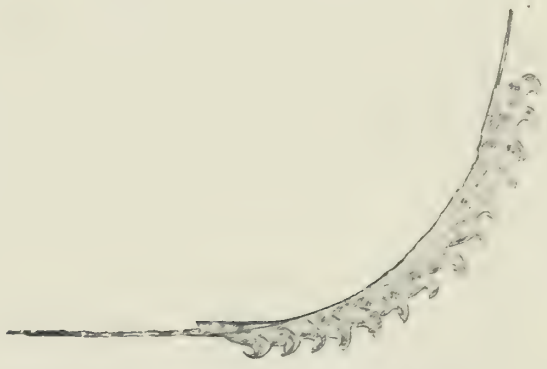
Monograptus flexilis, Elles. Plate XLIII, figs. 4 *a—e.*

1900. *Monograptus flexilis,* Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 407, fig. 18.

Polypary long and flexed, curvature variable, but always strongly reflexed proximally, widening gradually to a maximum breadth of 2 mm. Sicula very distinct, furnished with an exceedingly long virgella. Thecæ twelve to nine in 10 mm., of the general type of those of *M. Flemingii*, but with a somewhat shorter beak, which occupies a smaller fraction of the breadth of the polypary.

Description.—The polypary may attain a length of fully 22 cm. and in some cases makes a more or less complete ƨ-like curve, but smaller individuals are of commoner occurrence. The polypary itself widens gradually from an initial breadth of about 1 mm. to a maximum of about 2 mm., which is attained from 1·5 cm. to 2 cm. from the proximal end.

Fig. 293.—*Monograptus flexilis*, Elles.



Complete specimen, showing sicula and virgella. Near Gill, Cautley, Yorkshire; Wenlock Beds. Coll. Miss Welch.

The sicula is broad and measures nearly 2 mm. in length, reaching almost to the level of the aperture of th. 2. The long and stout virgella may be as much as 2·5 cm. in length, continuing the line of the polypary by that amount.

Affinities.—*Monog. flexilis* agrees with all the varieties of *M. Flemingii* in the general characters of its thecæ (though the retroversion of the apertural region is somewhat less pronounced), but the conspicuously flexed polypary and the lengthy virgella make it readily distinguishable.

Horizon and Localities.—Wenlock Shales (zone of *Cyrtog. Linnarssoni*).

Wales: Slate Quarries, Moel Ferna; Stream S. of Tomen-y-Meirw, Dee Valley. *Lake District:* Shap Wells; Rawthey Bridge, near Sedbergh; Middle Gill and

Near Gill, Cautley. *S. Scotland:* Moss Peeble Burn; Ewes Water, 6 miles N. Langholm; Kirkstile Burn, 4¾ miles N. by W. of Langholm.

Associates, etc.—Monog. flexilis is sometimes fairly abundant in the zone of *Cyrtog. Linnarssoni* occurring in association with the zone fossil, *Monog. comerinus* and var. *basilicus* and *M. dubius*; in the Lake District it has been found by Misses Watney and Welch with a fauna which appears to us to be characteristic of the same horizon.

Collections.—Geological Survey of Scotland, British Museum (Natural History), Watney and Welch, and Elles.

Monograptus acus, Lapworth MS. Plate XLIII, figs. 7 *a—c.*

1882. *Monograptus acus,* Lapworth (name only), Quart. Journ. Geol. Soc., vol. xxxviii, p. 660.

Polypary very long and flexed, 16 cm. or more in length, having an average breadth of 2 mm. Thecæ eight in 10 mm. of the type of those of *M. Halli*, but smaller and with rather less eversion and overlap.

Fig. 294.—*Monograptus acus,* Lapworth.

Thecæ in partial low relief. Enlargement of part of Pl. XLIII, fig. 7 *a*.

Description.—The polypary is remarkably flexed; the thecæ in the proximal portion are on the convex margin, while those of the distal region are on the concave side. The breadth is commonly uniform for the greater part of the length of the polypary, but a widening from 1 mm. to 2 mm. takes place rather gradually in the proximal portion.

The thecæ are of the type of the distal thecæ of *M. Halli*, though the very slight retroversion of the apertural region brings them very near in appearance to some of the members of the *convolutus* group.

Affinities.—Monog. acus agrees with *M. Halli* in the general type of its thecæ, but differs in the curvature of the polypary and the smaller, less everted thecæ. It seems to be identical with the form called by Nicholson *M. broughtonensis* in the paper on the Stockdale Shales by himself and Marr, but never described.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. crispus*).

S. Scotland: Grieston Quarry; Meigle Quarry; Tushielaw. *Lake District:* Knock, Edenside; Broughton Moor (?).

Associates, etc.—Monog. acus occurs associated with *M. galaensis*, etc., in Meigle Quarry.

Collections.—Sedgwick Museum, Marr, and Lapworth.

Monograptus undulatus, sp. nov. Plate XLV, fig. 5.

(?) 1850. *Graptolithus Becki*, Barrande, Grapt. de Bohême, p. 50, pl. iii, fig. 15.

Polypary several cm. in length, slender, flexed, generally with conspicuously recurved proximal end, increasing very gradually in width in the initial portion till the maximum breadth of 1 mm. is attained. Thecæ ten to eight in 10 mm., of the general type of those of the proximal portion of *M. Sedgwickii*, but with a broader retroverted apertural region, involving fully one-half of the thecal length, and occupying fully three-quarters of the total breadth of the polypary.

Description.—Throughout its length the polypary has usually both a limp and flexed appearance, though occasionally distal fragments may appear more rigid: it is uniform in breadth for the greater part of its extent, the widening taking place entirely in the proximal portion of the polypary.

FIG. 295.—*Monograptus undulatus*, sp. nov.

Proximal end, preserved as a cast, showing sicula. Enlargement of Pl. XLV, fig. 5.

The sicula measures 1·1 mm. in length, and th. 1, which arises near its base, has its highest region on a level with the apex of the sicula.

The isolated, broad, retroverted apertural region of the distal thecæ constitutes by far the most conspicuous feature of the polypary, the adnate portion being relatively insignificant. All the thecæ of the proximal portion are small, but they increase steadily in size till the maximum breadth of the polypary is attained.

Affinities. — *Monog. undulatus* presents some resemblance to the proximal end of *M. Sedgwickii* as regards the form of the polypary, but the thecæ are of a uniform type and remain small throughout the extent of the polypary, which is not the case in *M. Sedgwickii*.

Horizon and Localities.—Llandovery and Tarannon (?), zones of *M. convolutus* to *M. crispus* (?).

Wales: E. side of old Quarry, 800 yds. N.E. Fagrw Fawr, near Pont Erwyd.

Associates, etc.—Monog. undulatus occurs in Wales in the Pont Erwyd district in the zone of *M. convolutus*, associated with *M. Clingani*, *M. involutus*, *M. lobiferus*, *M. regularis*, etc.

Fragments recalling this species have been detected at higher horizons both in Scotland and elsewhere, but being merely fragments their specific determination is uncertain.

Collections.—Geological Survey of England and Wales.

Monograptus distans (Portlock). Plate XLIII, figs. 6 *a—d*.

1843. *Graptolithus* (*Prionotus*) *Sedgwickii* var. *distans*, Portlock, Geol. Report of Londonderry, p. 319, pl. xix. figs. 4 *a* and *b*.

Polypary long, slender, and irregularly but conspicuously flexed, several cm. in length, and with an approximately uniform breadth of about 1 mm. only. Thecæ similar throughout, twelve to eight in 10 mm., of the type characteristic of those of the more proximal part of *M. Sedgwickii*, though with rather less overlap, and with less conspicuous spines.

Description.—The polypary is always conspicuously flexed and as a rule the curvature is ventral, though this is not invariably the case. As with *M. Sedgwickii* the Irish specimens of *M. distans* are generally more flexed than those from other areas in the British Isles. The uniform breadth is attained fairly quickly.

Fig. 296.—*Monograptus distans* (Portlock).

Distal thecæ in low relief. Enlargement of part of Pl. XLIII, fig. 6 *c*.

The thecæ throughout are of the same general type; the apertural margin is *mucronate* rather than definitely *spinose*.

Affinities.—*Monog. distans* has a certain resemblance to proximal fragments of *M. Sedgwickii*, but the uniformly slender width of the polypary and the characters of the thecæ afford an easy means of separation.

Horizon and Localities.—Upper Llandovery (zone of *M. Sedgwickii*).

S. Scotland: The Corrie, Dobb's Linn, etc. *Wales:* River Twymyn, Llanbrynmair. *Ireland:* Desertcreight, Co. Tyrone; Limehill, Co. Tyrone; Little River, Pomeroy, Co. Tyrone.

Associates, etc.—*Monog. distans* is not uncommon in the *M. Sedgwickii* zone at Dobb's Linn, where it occurs in association with the zone fossil, *Monog. tenuis*, *Climacog. scalaris*, etc. It is met with a similar assemblage in Ireland and Wales.

Collections.—Geological Survey of England and Wales, Sedgwick Museum, Lapworth, and the Authors.

Monograptus scanicus, Tullberg. Plate XLIV, figs. 2 *a—d*.

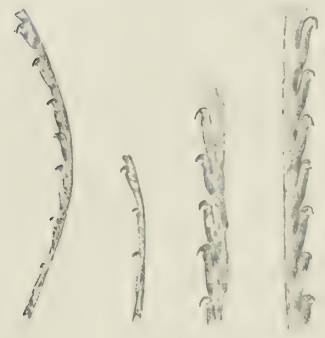
1883. *Monograptus scanicus*, Tullberg, Skånes Grapt., ii, p. 26, pl. ii, fig. 38.

1900. *Monograptus scanicus*, Wood, Quart. Journ. Geol. Soc., vol. lvi, p. 479, pl. xxv, fig. 25 *A* and *B*, text-figs. 22 *a* and *b*.

Polypary slender, very flexed, with conspicuous ventral curvature in the proximal portion, 15 cm. or more in length, widening from an almost thread-like initial portion to a maximum width of about 1 mm. Sicula conspicuous when preserved. Thecæ eight to nine in 10 mm., like that of *M. uncinatus* var. *orbatus*, but more elongated. Overlap about one-third the total length.

Description.—The polypary is strongly flexed, but the general form is variable. Usually the proximal portion shows marked ventral curvature, but it may show double curvature like that seen in *M. Nilssoni*. The more distal fragments have but a slight curvature, and eventually may be practically straight. Straight fragments fully 7·5 cm. in length are known, so that the total length of the polypary must have been considerable.

FIGS. 297 *a*—*d*.—*Monograptus scanicus*, Tullberg.



a *b* *c* *d*

a. Proximal fragment, showing sicula. Figured Quart. Journ. Geol. Soc., vol. lvi, p. 479, fig. 22 *b*. Aberedw Hill, Builth; Lower Ludlow Shales. Coll. Wood.

b. Proximal end. Specimen on same slab as fig. 102 *a*.

c. Distal thecæ. Figured Quart. Journ. Geol. Soc., vol. lvi, p. 479, fig. 22 *a*.

d. Distal thecæ in full relief. Elton-Ludlow Road, Ludlow; Lower Ludlow Shales. Coll. Wood.

The sicula is but rarely seen, but when preserved has a length of 1·5 mm. with short virgella; it reaches up to the level of the top of th. 1, which originates about one-third of the way along its length.

The thecæ are usually on the concave margin; they are in most respects like those of *M. uncinatus* var. *orbatus*, but are more elongated—in fact they bear precisely the same relation to the thecæ of that species as those of *M. irfonensis* to those of *M. priodon*.

Affinities.—The combination of flexed polypary and *uncinatus* type of theca serves to distinguish *Monog. scanicus* from all other species. Straight fragments have a superficial resemblance to *M. irfonensis*, but there is less ogee curvature; the thecal termination also is a smaller hook.

Horizon and Localities.—Lower Ludlow Shales (zone of *M. Nilssoni* and zone of *M. scanicus*).

Shropshire: Elton Lane, Ludlow; Elton-Evenhay Lane, Ludlow; Elton-Ludlow Road; Long Mountain. *Wales:* Aberedw Hill, Builth. *Worcestershire:* Abberley Hills.

Associates, etc.—*Monog. scanicus* occurs typically in the zone of *M. scanicus*, associated with *Monog. chimæra* and *M. Roemeri*; it also occurs at a lower horizon, namely, in the zone of *M. Nilssoni*, associated with *Monog. Nilssoni*, *M. bohemicus*, *M. dubius*, and *M. varians* var. *pumilus*.

Collections.—Sedgwick Museum, Lapworth, and Wood.

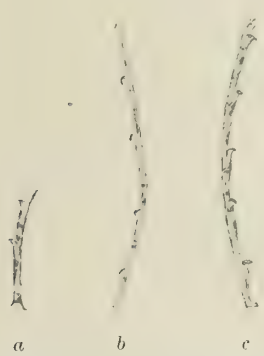
Monograptus crinitus, Wood. Plate XLIV, figs. 3 *a—c*.

1900. *Monograptus crinitus,* Wood, Quart. Journ. Geol. Soc., vol. lvi, p. 480, pl. xxv, figs. 26 A, B, text-figs. 23 *a—d*.

Polypary irregularly flexed, very slender, 8 cm. or more in length, widening from a thread-like proximal end to a maximum breadth of about ·4 mm. Thecæ five to seven in 10 mm., of the type of those of *M. scanicus* but far more slender. Overlap insignificant.

Description.—The polypary must have attained a considerable length, but only fragmentary specimens are found; this is not at all surprising considering its thread-like nature. The flexure is irregular; some fragments are practically straight, others convexly curved ventrally; the greater number, however, show ventral curvature with the thecæ on the concave margin. The general appearance of the species as presented on the rock is that of a tangle of hairs.

FIGS. 298 *a—c*.—*Monograptus crinitus,* Wood.



a. Fragment showing sicula. Figured Quart. Journ. Geol. Soc., vol. lvi, p. 481, fig. 23 *b*. Lower Winnington Lane, Long Mountain; Lower Ludlow Shales. Coll. Wood.
b. Proximal thecæ. Enlargement of part of Pl. XLIV, fig. 3 *b*.
c. More distal thecæ. Enlargement of part of Pl. XLIV, fig. 3 *a*.

The sicula has a length of about 1·5 mm., and th. 1 arises about half-way along its length.

The thecæ all show a beak-like apertural termination like that of *M. scanicus*, but are far more elongated and drawn out, the ventral walls running almost parallel with the line of the axis of the polypary.

Affinities.—*Monog. crinitus* shows distinct affinities with the other slender *Monograpti* belonging to the groups of *M. priodon* and *M. lobiferus*. From *M. gemmatus* it may, however, be readily distinguished if the thecæ are well preserved, since there is no definite hook as in that species, and from *M. Barrandei* it differs in the characters of the thecæ, the latter having more or less definitely coiled-up lobes at their apertural terminations.

Horizon and Locality.—Lower Ludlow Shales (zone of *M. Nilssoni*).

Shropshire.—Lower Winnington, N. side of Long Mountain.

Associates, etc.—*Monog. crinitus* has been found in some abundance at Lower Winnington, where it occurs in the zone of *M. Nilssoni* in association with *Monog. Nilssoni*, *M. varians* and *Retiolites (Gothog.) spinosus*.

Collections.—Sedgwick Museum, Wood.

Monograptus Jaekeli, Perner. Plate XLIV, figs. 1*a—b*.

1899. *Monograptus Jaekeli,* Perner, Grapt. de Bohême, pt. iii *b*, p. 4, pl. xv, figs. 1, 6—10, 20, 22, 24, 27, and text-fig. 8.

Polypary several cm. in length, conspicuously curved, widening steadily till the maximum breadth of 3 mm. is attained, and thereafter of approximately uniform breadth. Thecæ nine in 10 mm., of the general type of those of *M. priodon*, but with barely one-half of the theca involved in the short hook, which only occupies one-fifth of the total breadth. Overlap two-thirds of total length.

Description.—The polypary always shows pronounced curvature, but this is variable both in amount and in direction, the thecæ being borne usually on the convex, though occasionally on the concave margin. The width in the distal portion of the polypary is uniformly about 3 mm. The proximal portion is at present unknown in Britain.

Fig. 299.—*Monograptus Jaekeli*, Perner.

Distal thecæ. Enlargement of part of Pl. XLIV, fig. 1 *b*.

Affinities.—The theca of *Monog. Jaekeli* is very like that of *M. priodon* in its general shape, but the hook is much shorter and less of the theca is involved in it. The polypary, however, in the former is curved instead of being straight as in the latter.

Horizon and Localities.—Wenlock Shales (zone of *Cyrtog. Linnarssoni*).

Welsh Borders: Builth Road; Coppice House, near Middletown, Long Mountain.

Associates, etc.—*Monog. Jaekeli* seems to be characteristic of the Middle Wenlock Shales, in which it is found with *Cyrtog. Linnarssoni* and *M. vomerinus*.

Collection.—Sedgwick Museum.

Monograptus gemmatus (Barrande). Plate XLIII, figs. 5 *a*—*e*.

1850. *Rastrites gemmatus*, Barrande, Grapt. de Bohême, p. 68, pl. iv, fig. 5.
1868. *Rastrites capillaris*, Carruthers. Geol. Mag., vol. v, p. 126, pl. v, fig. 16.
1872. *Graptolithus attenuatus*, Hopkinson, Geol. Mag., vol. ix, p. 503, pl. xii, fig. 3.
1876. *Rastrites capillaris*, Lapworth, Geol. Mag. [2], vol. iii, p. 314, pl. x, figs. 4 *a*, *b*.
1876. *Monograptus attenuatus*, Lapworth, Geol. Mag. [2], vol. iii, p. 317, pl. x, figs. 9 *a*—*d*.
1897. *Monograptus gemmatus*, Perner, Grapt. de Bohême, pt. iii *a*, p. 10, pl. xi, figs. 30—32.

Polypary very slender and almost thread-like, arcuate, or nearly straight, widening from the finest thread in the proximal region to a maximum breadth of about ·5 mm. Thecæ generally on the convex side, six to nine in 10 mm., long narrow tubes with the extreme apical region isolate, twisted and retroverted to form a short but distinct hook occupying

rather more than one-half the total breadth of the polypary. Overlap insignificant.

Description.—The polypary is so slender in its proximal portion that little else than the short thecal hooks can be made out; these number from six to seven in 10 mm. As, however, the polypary increases in breadth the adnate region of the theca becomes proportionately more evident, and the theca as a whole becomes shorter and broader; the apertural region is a more pronounced hook, the apical extremity being bent over to run approximately parallel with the general direction of growth of the polypary. The torsion of the thecal axis results in the almost entire concealment of the hook in some views of the polypary.

FIGS. 300 *a*—*c*.—*Monograptus gemmatus* (Barrande).

a. Distal thecæ. Enlargement of part of Pl. XLIII, fig. 5 *a*.
b. Thecæ in full relief, with apertures embedded. Enlargement of part of Pl. XLIII, fig. 5 *c*.
c. Distal thecæ, showing form of apertures. Enlargement of part of Pl. XLIII, fig. 5 *e*.

Affinities.—There appears to have been considerable confusion regarding this species, resulting no doubt (1) from the extreme tenuity of the polypary, (2) from the difference in the shapes of the thecal hooks in its proximal and distal portions, (3) the failure to recognise and interpret the different appearances produced as the result of torsion of the thecal axis. *M. gemmatus* resembles in several respects other thread-like *Monograpti*, such as *M. Barrandei*, etc., but from these it may be distinguished by the nature of the apertural terminations, which are definite hooks in *M. gemmatus*, but lobes in the other species. From *M. crinitus*, another thread-like species, it differs in the characters of the thecæ, which are also rather more distant.

Horizon and Localities.—Llandovery (Birkhill Shales), zones of *M. gregarius*, *M. convolutus*, and *M. Sedgwickii*.

S. Scotland: Dobb's Linn; Belcraig Burn; Duffkinnel; Frenchland Burn; Kirk Gill; Ettrick Bridge End, etc. *Wales:* Conway; Parys Mountain. *Lake District:* Skelgill. *Ireland:* Coalpit Bay, Donaghadee.

Associates, etc.—*Monog. gemmatus* is a fairly common fossil in the higher parts of the Birkhill Shales in S. Scotland, occurring in the three highest zones in association with all their commoner graptolites. At Skelgill it occurs in the subzone of *M. fimbriatus*, associated with the zone fossil, *Rastrites approximatus*, and *M. triangulatus*.

Collections.—Geological Survey of Scotland, Sedgwick Museum, Lapworth, and the Authors.

IV. A. 2. (*b*): *Monograpti* in which the thecæ are uniform and the polypary shows spiral curvature.

Monograptus turriculatus (Barrande). Plate XLIV, figs. 4 *a—e*.

1850. *Graptolithus turriculatus*, Barrande, Grapt. de Bohême, p. 56, pl. iv, figs. 7—11.
1868. *Graptolites turriculatus*, Nicholson, Quart. Journ. Geol. Soc., vol. xxiv, p. 542, pl. xx, figs. 29, 30.
1876. *Monograptus turriculatus*, Lapworth, Geol. Mag. [2], vol. iii, p. 359, pl. xiii, figs. 6 *a—c*.
1881. *Monograptus turriculatus*, Linnarsson, Geol Fören. i Stockh. Förhandl., v, p. 518, pl. xxii, figs. 13—18.
1892. *Monograptus turriculatus*, Törnquist, Siljansområd. Grapt., ii, p. 38, pl. iii, figs. 24—26.
1897. *Monograptus turriculatus*, Perner, Grapt. de Bohême, p. 15, pl. xii, figs. 34—38.

Polypary usually small, coiled in a conical spiral from 1–3 cm. in length, widening from a somewhat slender proximal portion, which forms the apex of the cone, to an average breadth of about 1 mm. (exclusive of spines). Sicula conspicuous. Thecæ twelve in 10 mm. of the general type of *M. Sedgwickii* but apparently with two spines. Overlap increasing to one-half the total length as a maximum.

Description.—The appearance of this species varies very much in different individuals, as the result of compression upon a polypary of such peculiar form. The most typical and characteristic appearance is that of a symmetrically grown conical spire, but the spire may be unsymmetrically compressed. Not infrequently it is compressed from its apex, and then presents a disc-like appearance not unlike that of *M. discus*.

The sicula, which is curved, measures 1·2 mm., and reaches nearly to the top of th. 2.

The early thecæ are all small and possess spined apertural margins, and in the more distal thecæ these spines measure 2 mm. or more in length. Some of the thecæ, if not all, seem to have two spines, for when compressed one appears to come from the back and one rom the front of the theca.

Figs. 301 *a—c*.—*Monograptus turriculatus* (Barrande).

a. Complete specimen, showing conspicuous sicula. River Twymyn, Llanbrynmair; Brynmair Beds. Coll. Wood.
b. Thecæ, showing apertural spines. Meigle Quarry, S. Scotland; Gala Beds. Coll. Lapworth.
c. Specimen, showing the two apertural spines. Enlargement of part of Pl. XLIV, fig. 4 *e*.

Affinities.—In its usual state of preservation the shape of *Monog. turriculatus* is unique, and in its characteristic habit it could not be confused with any other graptolite; when compressed, however, from the apex of the cone it presents a superficial resemblance to *M. discus*, but may be easily distinguished by the spined nature of the thecæ.

Horizon and Localities.—Lower Gala-Tarannon Beds.

Wales: Forge Corner, Conway; Llanystwmdwy; Tarannon River; Gelli-dywyll Stream; Gelli Stream; Pontbren-dibyn, near Llanbrynmair, etc.

S. Scotland: Belcraig Burn; Ladhope; Bargany Pond Burn; Buckholmside, Galashiels, etc. *Lake District:* Swindale Beck; Spengill; Rawthey Bridge, Sedbergh, etc. *Ireland:* Tieveshilly.

Associates, etc.—*Monog. turriculatus* ranges throughout the whole thickness of the Lower Tarannon Shales, but is comparatively rare in the *Rastrites maximus* band at the base of the zone of *M. turriculatus*, where it occurs in association with *R. maximus*, *Petalog. altissimus*, *Monog. nudus*, *M. dextrorsus*, *M. Halli*, *M. runcinatus* and other forms. It is far commoner in the higher parts of the zone of *M. turriculatus*, where it is found with *M. runcinatus*, *M. Marri*, *M. nodifer*, etc., but becomes rarer again in the higher zone of *M. crispus*, where it occurs with *M. crispus*, *M. exiguus* and *M. Marri*.

Collections.—Geological Survey of Scotland, Sedgwick Museum, Lapworth, and the Authors.

Monograptus discus, Törnquist. Plate XLIV, figs. 5 *a—d*.

1883. *Monograptus discus*, Törnquist, Bergbyggn. inom Siljansområdet, Svensk. Geol. Undersök., ser. c, pp. 24, 25.

1892. *Monograptus discus*, Törnquist, Siljansområdets Grapt., ii, p. 39, pl. iii, figs. 27, 28.

Polypary very small, coiled into a close plane spiral so as to appear like a small disc; widening very rapidly from origin to a maximum breadth of about 1·5 mm. Sicula very long and conspicuous. Thecæ twenty to sixteen in 10 mm., of the general type of those of *M. priodon*, but broader in proportion to their length, the hook occupying only one-third of the total breadth of the polypary.

a b c

Figs. 302 *a—c.*—*Monograptus discus*, Törnquist.

a. Young specimen, showing sicula. Afon Tyn-y-rhos, Talerddig, near Llanbrynmair; Talerddig Beds. Coll. Wood.

b. Somewhat larger specimen. Ibid.

c. Large specimen, showing form of thecæ. Tarannon River, Montgomeryshire; Gelli Beds. Coll. Wood.

Description.—The small disc-like form of the polypary is highly characteristic of this species, though there is considerable variety in different individuals as respects the closeness of the coil, and hence the perfection of the disc. The outline of some forms is practically circular, the circle measuring about 4 mm. in diameter, but others are subelliptical and measure 4 by 6 mm.

The sicula is curved, and relatively very long and conspicuous, measuring 1 mm. in length and reaching practically to the top of th. 2.

Compared with the size of the polypary, the thecæ are relatively large, and increase in size steadily from the proximal to the distal end of the polypary. They are broad rather than long, and very closely set.

Affinities.—*Monog. discus* is such a peculiar species in respect of its disc-like habit and small size that it could hardly be confused with any other. Occasionally, however, a specimen of *M. turriculatus* compressed from the apex of the conical spire may present a somewhat similar disc-like appearance; but in this case long spines project in all directions from the disc or its component coils, and the thecæ are of a totally distinct type.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. crispus* to zone of *M. comerinus* var. *crenulatus*).

S. Scotland: Rotten Gair, head of Walker Burn, Innerleithen; Old Quarry at Cascade, 3½ miles S.W. of Melrose; Meigle Quarry, Galashiels; Grieston. *Ireland:* Portaferry. *Wales:* Bryn yr odin, near Llangollen; Tarannon River; Afon Cwm Calch; Talerddig Railway Cutting; Gelli Stream, near Llanbrynmair; Pen-y-geulan, Wynnstay, etc. *Lake District:* Rawthey Bridge, Sedbergh.

Associates, etc.—*Monog. discus* is a fairly common fossil in the Gala-Tarannon beds, though it does not seem to occur in the lowest beds of the series; in the zone of *Monog. crispus* it occurs with *M. crispus*, *M. exiguus* and *M. Marri*, it is also found with *M. griestoniensis* at a higher horizon, and more sparingly with *M. comerinus* var. *crenulatus* and *M. priodon* at the top of the Gala-Tarannon Series.

Collections.—Geological Survey of Scotland, Belfast Natural History Museum, L. J. Wills, Lapworth, and the Authors.

Monograptus tortilis, Linnarsson. Plate XLIV, fig. 6.

1881. *Monograptus tortilis*, Linnarsson, Geol. Fören. i Stockholm Förhandl., no. 68, vol. v, no. 12, p. 514, pl. xxii, figs. 19, 20.

Polypary 3—4 cm. in length, arcuate (? spiral), incurved, fairly robust, widening from its initial region to a maximum breadth of 1·5 mm. or more. Thecæ nine to ten in 10 mm., of the general type of those of *M. Marri*, but with the isolate apertural region less recurved, and with rather less than one-half of the theca involved in the hook, which occupies about two-thirds of the breadth of the polypary. Overlap one-half to one-third of total length.

Description.—The polypary exhibits strong curvature, with the thecæ on the concave edge; it frequently has a curiously bent appearance, as if it were broken or had grown sub-spirally; in the specimens known it is seen to widen slightly throughout its length.

The thecæ are of the general type of those of *M. Marri* with a similarly distinct

Fig. 303.—*Monograptus tortilis*, Linnarsson.

Enlargement of part of Pl. XLIV, fig. 6.

tendency to isolation though with a less conspicuous and shorter hook. The overlap appears to vary from one-half in the proximal portion of the polypary to one-third in its more distal portion.

Affinities.—*Monog. tortilis* can readily be distinguished from all other members of the group by its form and the characters of its thecæ.

Horizon and Localities.—Gala-Tarannon Beds.

Lake District: Sedbergh.

Associates.—*Monog. tortilis* is a rare species in Britain. It occurs associated with *Monog. Becki*, *M. nudus*, and *Petalog. palmeus*.

Collection.—Sedgwick Museum.

IV. B. 1: *Monograpti* in which the thecæ are bi-form and the polypary approximately straight.

Monograptus Sedgwickii (Portlock). Plate XLIV, fig. 10 *a—f*.

1843. *Graptolithus (Prionotus) Sedgwickii*, Portlock, Report Geol. of Londonderry, p. 318, pl. xix, fig. 1.

1850. *Graptolites Sedgwickii*, Harkness, Quart. Journ. Geol. Soc., vol. vii, p. 60, pl. i, fig. 4.

1868. *Graptolites Sedgwickii* and var. *spinigerus*, Nicholson, Quart. Journ. Geol. Soc., vol. xxiv, p. 533, pl. xix, figs. 31, 32.

1876. *Monograptus Sedgwickii*, Lapworth, Geol. Mag. [2], vol. iii, p. 357, pl. xiii, figs. 3 *a—d*.

1892. *Monograptus Sedgwickii*, Törnquist, Siljansområd. Grapt., ii, p. 28, pl. ii, figs. 31—34; pl. iii, figs. 1—4.

Polypary straight or slightly flexed, 20 cm. or more in length, widening gradually from the proximal end to a maximum breadth of 3 mm. exclusive of spines. Sicula relatively small. Thecæ ten to six in 10 mm., with slight ogee curvature and slight torsion; apertural region alone isolate and retroverted, occupying about one-half the breadth of the polypary. Apertural margin spined, the spine becoming more conspicuous distally and the amount of retroversion decreasing proportionately. Overlap slight.

Description.—The polypary must often have attained a great length, for distal fragments measuring 12 cm. or more are of frequent occurrence. These distal fragments are commonly rigid and straight; but Portlock's specimens from Ireland —possibly his original types of the species, and at present preserved in the Jermyn Street Museum—show an unusual amount of curvature throughout when compared

with the majority of examples known from elsewhere. Proximal fragments, however, wherever they are met with, are distinctly flexed in all cases and have a general *limp* appearance.

The sicula in this species is relatively small, measuring about 1·4 mm. in length.

All the earliest thecæ are small, with distinctly retroverted apertural regions occupying two-thirds of the breadth of the polypary and strongly recalling those of *M. priodon*. As the thecæ successively increase in size, however, the proportion of the retroverted part of the apertural region presents the appearance of correspondingly diminishing in amount, until finally only the plane of the apertural margin itself faces the proximal end of the polypary and occupies only one-third of its total breadth. This apertural margin is not infrequently thickened in the larger and more distal thecæ, and this thickening is often produced outward as a distinct and conspicuous spine. In the most distal thecæ there is comparatively little retroversion shown in the apparent ventral edge, while the spine has become the conspicuous feature of the theca (Fig. 304 *d*). In the proximal part of the polypary the spine is, as a rule, insignificant even in well-preserved specimens, although the aspect be such as to place it in such a position that its entire length is presented to the observer. There is one aspect of the polypary (reverse) in which, as the result of the torsion of the thecal axis, the spine may be more or less completely hidden from the observer behind the intervening membrane of the thecal wall, or embedded in the rock matrix; and even in the case of the obverse aspect the spine may be non-apparent for much or the whole of its length, being pressed down upon the upper surface of the fossil. But the variations noted above in the appearances presented by the thecæ have all been observed in one and the same individual in several different specimens (compare Figs. 304 *d* and *e*).

FIGS. 304 *a*–*c*.—*Monograptus Sedgwickii* (Portlock).

a. Proximal end, showing sicula and form of proximal thecæ. Enlargement of part of Pl. XLIV. fig. 10 *c*.
b. Slightly more distal thecæ, showing form of apertural margin and beginning of spine. Plewlands Burn, Raehills, S. Scotland; Birkhill Shales (Zone of *Monog. Sedgwickii*). Geol. Survey of Scotland.
c. More distal thecæ with longer spines. Parys Mountain, Anglesea; Llandovery Beds. Geol. Survey of England and Wales.

Spines are certainly present on Portlock's examples, though all specimens obtained from his typical locality of Limehill are so poorly preserved that the detection of the spines is a matter of some difficulty. In specimens from the Lake District, on the other hand, the spines are often very beautifully seen, extending some 2—3 mm. beyond the thecal margins. It was to these conspicuously spined Lake District examples that Nicholson applied the name var. *spinigerus*. Since, however, the Irish specimens have spines also and the perfection in which they are

Figs. 304 *d*, *e*.—*Monograptus Sedgwickii* (Portlock).

d

e

d. Mature thecæ, compressed, with conspicuous spine. Duffkinnel Burn, Wamphray, S. Scotland; Upper Birkhill Shales. British Museum (Nat. Hist.)

e. Part of same specimen, in relief, showing that the spines may be completely concealed.

seen would seem to be largely a matter of preservation, this specific or varietal separation of the Lake District forms does not appear to us to be justifiable, and we have therefore united all under Portlock's original designation.

Affinities.—The proximal end of *Monog. Sedgwickii* closely resembles that of *M. Halli* and *M. undulatus*. From *M. Halli* this species, generally speaking, may be distinguished by (1) its less rapid increase in breadth, (2) the more flexed character of distal fragments, (3) the lesser amount of overlap of the thecæ, and (4) the greater retroversion of the apertural regions. In *M. undulatus* the thecæ are never spined, and there is no change either in the character of the thecæ as in *M. Sedgwickii*, the proximal type persisting throughout, or in the breadth of the polypary, which remains slender from end to end.

Horizon and Localities.—Upper Llandovery (zone of *M. Sedgwickii*).

S. Scotland: Dobb's Linn; Belcraig Burn; Sundhope-on-Yarrow; Selcoth Burn; Lockerbie; Plewlands Burn, Raehills. *Ireland:* Limehill, co. Tyrone; Side Valley, Little River, Pomeroy. *Lake District:* Skelgill; Tributary, Haw Gill; Torver Beck; Long Sleddale; Browgill. *Wales:* Tributary of River Twymyn, Llanbrynmair; Morben Quarry, Machynlleth; Nant Fuches-wen, Pont Erwyd; Rheidol Gorge, Pont Erwyd; Parys Mountain, Anglesea.

Associates, etc.—*Monog. Sedgwickii* is usually an abundant fossil wherever the rocks of the Upper Llandovery afford graptolites. It is commonly associated with *Monog. tenuis*, *M. Clingani*, *M. regularis*, *Climacog. scalaris*, and *Glyptog. serratus* var. *barbatus*.

Collections.—Geological Survey of England and Wales, and of Scotland, Sedgwick Museum, Jones, Lapworth, and the Authors.

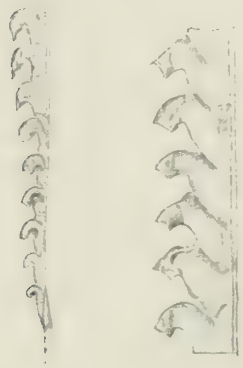
Monograptus Halli (Barrande). Plate XLIV, fig. 8 *a—f*.

1850. *Graptolithus Halli*, Barrande, Grapt. de Bohême, p. 48, pl. ii, figs. 12, 13.
1876. *Monograptus Halli*, Lapworth, Geol. Mag. [2], vol. iii, p. 354, pl. xiii, figs. 1 *a—d*.
1880. *Monograptus crassus*, Lapworth, Ann. Mag. Nat. Hist. [5], vol. v, p. 155, pl. iv, fig. 8 *b*.

Polypary long, resembling that of *M. Sedgwickii* in general form, but straighter

and more rigid, and having a proximal portion which is more robust to start with, and widens more rapidly to the maximum breadth of 3 mm. (exclusive of the spines). Sicula relatively small. Thecæ eleven to seven in 10 mm., resembling those of *M. Sedgwickii*, but with less retroversion of the apertural region of the thecæ, especially distally, and with shorter and stouter apertural spines. Overlap one-third to one-half of the thecal length.

Description.—The polypary of *M. Halli*, like that of *M. Sedgwickii*, must often have been of considerable extent, but is characteristically straighter and stiffer throughout, and the proximal region more robust, the maximum breadth being attained fairly rapidly.



Figs. 305 *a* and *b*.—*Monograptus Halli* (Barrande).

a. Proximal end of specimen, probably referable to this species; length of sicula rather uncertain. W. side of Upper Quarry, 550 yards E.S.E. of Faches-gau Farmhouse, Pont Erwyd, Cardiganshire. Geol. Survey of England and Wales.

b. More distal portion, preserved as a cast. Quarry S. side main road from Devil's Bridge to Rhayader, 200 yards S. of Bodcoll Farm, Cardiganshire. Geol. Survey of England and Wales.

The thecæ of the proximal portion resemble in general those of the corresponding portion of *M. Sedgwickii*, but are somewhat larger and have more conspicuous overlap; while the thecæ of the distal portion lose their retroverted character still more quickly and more completely than the corresponding thecæ of *M. Sedgwickii*. Finally, the retroversion becomes so slight that the *eversion* is the more prominent characteristic, though in specimens preserved in relief it is clear from the way in which the thecæ grow that there is still a distinct *tendency* towards retroversion. The apertural spine is short and stiff.

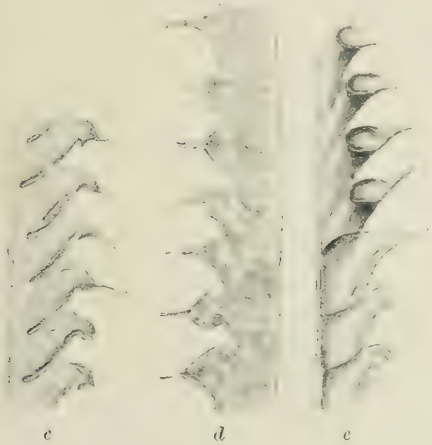
From certain specimens it would seem that the torsion of the thecal axis in *Monog. Halli* may be in an opposite direction (*i. e.* negative) to that which obtains as the rule in *M. Sedgwickii*, etc. (see Text-fig. 305 *e* and Pl. XLIV, fig. 8 *d*). The scarcity of specimens preserved in relief makes it impossible at present to determine if this character is constant in this species and confined to it.

In compressed examples of *M. Halli*, as in *M. Sedgwickii*, two extreme views or appearances are presented to the observer as a natural consequence of the torsion of the thecal axis apart from the direction of torsion. These may conveniently be distinguished as (1) a *spinigerus* appearance, and (2) a *non-spinigerus* (or *Sedgwickii*) appearance, and these are connected by intermediate gradations.

The extreme *spinigerus* appearance is that in which compression has taken effect in the plane which includes both the terminal part of the thecal axis and the spine itself. In this case the apertural margin of the theca is typically shown as an approximately straight line, and the spine is displayed in its real length. In the *Sedgwickii* or *non-spinigerus* appearance compression has

taken effect at oblique angles to the plane above-mentioned. In proportion as the degree of obliquity of compression increases, (1) the line marking the extreme visible edge of the aperture takes on a more and more curved form; (2) the spine itself becomes more and more foreshortened, and correspondingly less and less conspicuous; (3) simultaneously presents the appearance of originating from a different point along the apertural margin; and (4) of proceeding in a different direction. These different appearances naturally answer to the varying perspective views of a specimen preserved in full relief.

FIGS. 305 *c—e.*—*Monograptus Halli* (Barrande).



c *d* *e*

c. Fragment in median portion of the polypary, preserved in low relief, and showing apertural margins and short spines. Belcraig Burn, near Moffat; Upper Birkhill Shales. Coll. Lapworth.

d. Distal thecæ, showing various appearances presented by compression. Belcraig Burn, near Moffat; Upper Birkhill Shales (Band of *Rastrites maximus*). Coll. Lapworth.

e. Upper part preserved in full relief, lower part as a cast; thecæ in relief show the slightly retroverted apertures. Ibid.

Affinities.—From what has been said above it is clear that *Monog. Halli* must be carefully distinguished from *M. Sedgwickii* from which it differs in (1) general form, being straighter and stiffer throughout, and (2) having distal thecæ which have a greater amount of overlap, show even less retroversion of the apertural region, and have shorter and shorter apertural spines. In certain specimens from the Pont Erwyd district which are preserved in relief, the spines are not at all a conspicuous feature and the retroverted character of the thecæ is carried further along the polypary than usual; the distal thecæ are, however, of the true *Halli* type.

Horizon and Localities.—Gala-Tarannon Beds (especially zone of *M. turriculatus*).

S. Scotland: Belcraig Burn; Ettrick Bridge End; Dobb's Linn; Caddon Water; Caddon Head, $6\frac{1}{2}$ miles W.N.W. Galashiels Station; Old Quarry, West Mains, Old Cambus, Cockburnspath. *Wales:* Conway; Nant Fuches-wen, and Rheidol Gorge, Pont Erwyd. *Lake District:* Applethwaite Beck.

Associates, etc.—*Monog. Halli* is a fairly abundant fossil in the beds at the very base of the Gala-Tarannon Series. In South Scotland it occurs in the *Rastrites maximus* band in the *M. turriculatus* zone associated with *R. maximus*, *M. turriculatus*, *M. runcinatus*, *M. nudus*, *M. dextrorsus*, *Petalog. altissimus* and *Climacog. extremus*. It also occurs with a very similar association in the *M. turriculatus* zone of Wales.

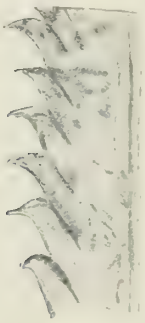
Collections.—Geological Survey of England and Wales, and of Scotland, Jones, Lapworth, and the Authors.

Monograptus M'Coyi, Lapworth. Plate XLIV, figs. 9 *a* and *b*.

1877. *Monograptus M'Coyi*, Lapworth, Proc. Belfast Nat. Field Club, p. 130, pl. vi, fig. 2.

The specimen upon which this species was founded is re-figured on Pl. XLIV, fig. 9 *a*, so that there may be no doubt of its identity. It is, however, so poorly preserved that little or no detail can be made out, and certain features lead us even to be doubtful of its reference to the genus *Monograptus*. There are, however, certain broad *Halli*-like forms which might be referred to it, but we feel doubtful if these have a more than local value (Pl. XLIV, fig. 9 *b*).

FIG. 306.—*Monograptus M'Coyi*, Lapworth.



Fragment doubtfully referable to this species. Enlargement of part of Pl. XLIV, fig. 9 *b*.

The original specimen has a length of 7·5 cm. and a maximum width of 3·5 mm. The thecæ number ten in 10 mm., and so far as can be made out approach the distal thecæ of *M. Halli* in their general characteristics.

Horizon and Localities.—Tarannon Beds.

Ireland: Tieveshilly, Co. Down. *Scotland:* Belcraig ?.

Collections.—Belfast Natural History Museum, Geological Survey of Scotland.

IV. B. 2: *Monograpti* in which the thecæ are bi-form and the polypary shows spiral curvature.

Monograptus testis var. **inornatus** Elles. Plate XLIV, figs. 7 *a* and *b*.

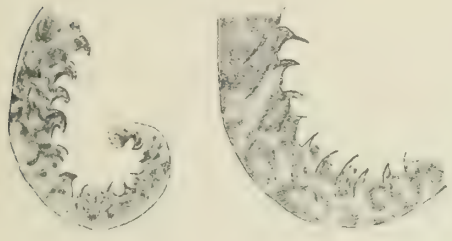
1900. *Monograptus testis* var. *inornatus*, Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 408, fig. 20.

This British variety is a small *Monograptus* agreeing with Barrande's *M. testis* in general form, but apparently differing in the minor characters of the thecæ, which are rather of the type of those of the proximal portion of *M. Sedgwickii*, and seem to be devoid of the long apertural spines which are so conspicuous a feature of the Bohemian examples of *M. testis*. Nevertheless, the British specimens at present known are not sufficiently well preserved to make it certain whether the thecæ might have spines like *M. Sedgwickii* (Fig. 307 *b*) or not; and they are all proximal fragments, so that it is possible that in complete examples the spines may be conspicuous in the distal region alone. The proximal thecæ of the Bohemian form of *M. testis* are more distant, and never show the retroverted apertural regions

which are characteristic of the British form; hence the latter is here provisionally regarded as a distinct variety.

The polypary is small, measuring only about 1 cm. in the specimens known, and has a maximum breadth of 2 mm. The thecæ number fifteen in 10 mm., and have conspicuously retroverted apertural regions, and, as above mentioned, the apertural margin appears to be devoid of long spines.

FIGS. 307 *a* and *b*.—*Monograptus testis*, var. *inornatus*, Elles.



a *b*

a. Specimen showing *priodon*-type of thecæ. Enlargement of part of Pl. XLIV, fig. 7 *a*.
b. Thecæ showing indications of apertural spines. Enlargement of part of Pl. XLIV, fig. 7 *b*.

Horizon and Localities.—Upper Wenlock Shales (zone of *Cyrtog. Lundgreni*).

Shropshire: Trewern Brook, near Middletown; Garbett's Hall, near Middletown; Ackley Lane, Long Mountain.

Associates, etc.—*Monog. testis* var. *inornatus* appears to be a rare fossil, and seems to be confined to the *Cyrtog. Lundgreni* zone, where it occurs in association with the zone fossil, *M. Flemingii* var. *compactus* and *M. dubius*.

Collections.—Professor W. W. Watts, and the Authors.

GROUP V.

Monograpti in which the mature thecæ are tubes with the whole apertural region coiled into a definite lobe.

In the *Monograpti* included in the present group the isolation and retroversion of the apertural region of the theca are still further intensified. The theca in the course of its development becomes as it were folded back upon itself, its axis curving through a thecal angle exceeding 180°, and the whole of the apertural region is rolled into a distinct coil or "lobe." This may be coiled tightly as in *M. knockensis*, or loosely as in *M. runcinatus*.

In all cases there is considerable torsion of the theca, so that after compression, what seem to the eye to be shortened or lengthened appearances of the thecæ are often presented, giving the polypary a very different look in the two cases. These diverse appearances seem sometimes to have been interpreted as belonging to distinct species.

Considerable differences exist in the amount of the thecal length which is isolate (*i. e.* prolonged beyond the final point of overlap), and also in the proportion of this amount which is involved in the lobe itself; distinctions which when constant appear to constitute characters of specific value. Again, the transverse diameter of the lobe in some species is small compared with the breadth of the polypary as a

whole (*M. capillaceus*), while in others the lobe is by far the most conspicuous feature, and an adnate (or overlapped) region of the theca appears to be almost wanting, or at all events is relatively insignificant (*M. lobiferus*, *M. Barrandei*).

In this group the appearances resulting from the direction of compression and the state of preservation are even more varied and pronounced than in the group of *M. priodon*, owing to the greater degree of torsion of the theca. Here, as in all forms of Monograptidæ, there would seem to be four more or less distinct right-hand views, and four more or less distinct corresponding left-hand views according as to whether the theca is preserved (*a*) in full relief, (*b*) half relief, (*c*) split down the centre, or (*d*) partly split and partly in relief.

In this group the thecæ are uniform in type throughout and all the polyparies are curved. They may be sub-divided as follows:

(*a*) The polypary has *dorsi-ventral* curvature. Type *Monograptus lobiferus*.
M. runcinatus, var. *pertinax*, *M. Becki*, *M. exiguus*, *M. nodifer*, *M. crispus*, *M. flagellaris*, *M. capillaceus*, *M. retroflexus*, *M. dextrorsus*, *M. remotus* (?).

(*b*) The polypary has *ventral* curvature (?).
M. Barrandei, *M. knockensis*.

(*c*) The polypary has *dorsal* curvature. Type *Monograptus Clingani*.
M. millepeda.

V (*a*): *Monograpti* with lobed thecæ in which the polypary has dorsi-ventral curvature.

Monograptus lobiferus (M'Coy). Plate XLV, figs. 1 *a—f*.

1850. *Graptolites lobiferus*, M'Coy, Ann. Mag. Nat. Hist. [2], vol. vi, p. 270.
1851. *Graptolites Becki*, Harkness, Quart. Journ. Geol. Soc., vol. vii, p. 60, pl. i, fig. 6.
1851. *Graptolites Nicoli*, Harkness, Quart. Journ. Geol. Soc., vol. vii, p. 61, pl. i, fig. 5.
1855. *Graptolites lobiferus*, M'Coy, Brit. Pal. Foss., p. 4, pl. i B, fig. 3.
1868. *Graptolites lobiferus*, Nicholson, Quart. Journ. Geol. Soc., vol. xxiv, p. 532, pl. xxx, fig. 30.
1876. *Monograptus lobiferus*, Lapworth, Geol. Mag. [2], vol. iii, p. 26, pl. xx, figs. 1 *a*, *b*, *d*.
1892. *Monograptus lobiferus*, Törnquist, Siljansområd. Grapt., ii, p. 18, pl. i, fig. 37; pl ii, figs. 1, 2, 3.
1899. *Monograptus harpago*, Törnquist, Monog. of Scanian *Rastrites* Beds, p. 16, pl. iii, figs. 3–11.

Polypary slender, flexed or straight, several cm. in length, widening fairly quickly from an initial breadth of about ·2 mm. to a maximum of about 2 mm. which is then maintained. Thecæ ten to seven in 10 mm., with fully three-quarters of the thecal length involved in the conspicuous lobe which occupies about three-quarters of the total breadth of the polypary. Overlap insignificant.

Description.—The polypary must often have attained a great length, for frag-

Figs. 308 *a* and *b*.—*Monograptus lobiferus* (M'Coy.).

a *b*

a. Proximal end, showing sicula. Enlargement of part of Pl. XLV, fig. 1 *e*.

b. More distal portion of same specimen, in full relief.

Figs. 308 *c*—*e*.—*Monograptus lobiferus* (M'Coy).

c *d* *e*

c. Proximal fragment, preserved partly in relief, partly as a cast. Llanystwmdwy, near Criccieth. Coll. Fearnsides.

d. Distal thecæ in relief, showing some of the apertures partly facing and others partly turned away from the observer. Skelgill Beck, Ambleside; Skelgill Beds. Coll. Sedgwick Museum.

e. Compressed thecæ, reverse aspect. Enlargement of part of counter-impression of Pl. XLV, fig. 1*f*.

ments 8 cm. or more in extent are known, and they exhibit every degree of flexure. Sometimes there is conspicuous curvature, with the thecæ on the concave margin, at others slight irregular flexure, the polypary being at first concavely and then convexly curved. Occasionally long fragments are met with which appear to be so slightly flexed that they are practically straight. The proximal end is slightly recurved, but the curvature only involves a few of the earlier thecæ.

The sicula is small, not exceeding 1·2 mm. in length, and th. 1 originates near its base and terminates a little distance below its apex.

The thecæ throughout are of one general type. The characteristic feature is the prominence of the lobe, the round or disc-like appearance of which is clearly due to the retroversion and torsion of the whole apertural region. This is coiled upon itself in such a manner that, after compression, the plane of the aperture almost faces the general line of the polypary, but is slightly twisted, so that the actual thecal aperture is seen in one aspect only (the obverse), where it practically faces the observer. In this aspect the roundness of the lobe is accentuated by foreshortening. In the other aspect (the reverse), where no aperture at all is visible, the lobe is turned away and the adnate region of the theca is relatively more conspicuous.

Affinities.—There appears to have been some confusion in the minds of palæontologists between *Monog. lobiferus* and its ally *M. millepeda*, both of which were amongst the earliest graptolites to be described. *M. millepeda* is a form which is in reality quite distinct from *M. lobiferus*, but the name of the latter species often appears as a synonym for that of the former. This seems to be due to the fact that the strongly recurved proximal end of *M. millepeda* has been erroneously figured as belonging to *M. lobiferus* (Lapworth, Geol. Mag., 1876, pl. xx, fig. 1, *c*, *d*, *e*), whereas the proximal end of *M. lobiferus* is but slightly recurved and involves but few thecæ. This mistake led Törnquist to describe as distinct a third species, viz. *M. harpago*, in which the proximal end was

nearly straight and therefore differed conspicuously from those previously figured as belonging to *M. lobiferus*, though he frankly admitted that the distal fragments of his new species and those of the accepted *M. lobiferus* were practically the same. In our opinion there are but two forms in all, namely *M. lobiferus*, with its conspicuous lobes and slightly recurved proximal end, and *M. millepeda*, with strongly recurved proximal end and with less conspicuous lobes in which a smaller fraction of the theca is involved.

Horizon and Localities.—Llandovery (zone of *M. convolutus*).

S. Scotland: Lockerbie; Dobb's Linn; Belcraig Burn; Garple Linn; Duffkinnel. *Lake District:* Skelgill. *Wales:* Llanystwmdwy; W. side of old quarry 800 yds. N.E. Fagwr-fawr, 2 miles E.N.E. of Pont Erwyd; River Twymyn, near Llanbrynmair. *Ireland:* Donaghadee.

Associates, etc.—*Monog. lobiferus* is a very abundant fossil in the Graptolite Shales of Middle Llandovery age in the zone of *M. convolutus*, where it occurs with *M. convolutus*, *M. limatulus*, *M. involutus*, *M. communis*, *M. regularis*, *Orthog. bellulus*, *Climacog. scalaris*, *Petalog. folium*, etc.

Collections.—Geological Survey of England and Wales, Geological Survey of Scotland, Sedgwick Museum, Fearnsides, Lapworth, and the Authors.

Monograptus runcinatus, Lapworth. Plate XLV, figs. 2 *a*—*g*.

1876. *Monograptus runcinatus,* Lapworth, Scott. Monograptidæ, Geol. Mag. [2], vol. iii, p. 28, pl. xx. fig. 4.

Figs. 309 *a*—*c*.—*Monograptus runcinatus,* Lapworth.

a *b* *c*

a. Proximal end, showing sicula, in relief. Enlargement of part of Pl. XLV, fig. 2 *a*.

b. Proximal fragment preserved as a cast. Quarry, S. side main road from Devil's Bridge to Rhayader, 200 yards S. of Bodcoll Farm, Cardiganshire. Geol. Survey of England and Wales.

c. Proximal part of somewhat more rigid specimen, probably referable to this species. W. side of Upper Quarry, 550 yards E. of Faches gau Farm, Cardiganshire Geol. Survey of England and Wales.

1876. *Monograptus runcinatus,* Lapworth, Cat. West Scott. Foss., pl. i, fig. 26.

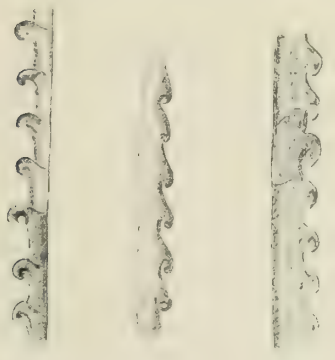
1877. *Monograptus runcinatus,* Lapworth, Grapt. Co. Down, Proc. Belfast Nat. Field Club, p. 128, pl. v, fig. 7.

1881. *Monograptus runcinatus,* Linnarsson, Graptolitskiffer med *M. turriculatus* vid Klubbudden., Geol. Fören. i Stockh. Förhandl., vol. v, p. 513, pl. xxiii, figs. 8—12.

1892. *Monograptus runcinatus,* Törnquist, Siljansområd. Grapt., ii, p 27, pl ii, figs. 29, 30.

Polypary slender, somewhat flexed, especially in the proximal portion, several cm. in length, widening gradually from ·3 mm. to a maximum breadth of 1·5 mm. Thecæ eleven to eight in 10 mm. usually on concave margin, those of the proximal portion with fully one-half of the thecæ isolated and retroverted to form a free lobe occupying about one-third the breadth of the polypary; distally this lobe becomes pressed close against the adnate

Figs. 309 *d—f.*—*Monograptus runcinatus*, Lapworth.



d *e* *f*

d. Specimen partly in relief, partly a cast. Llanystwmdwy, near Criccieth; Llandovery Beds. Coll. Fearnsides.

e. Distal thecæ in relief, showing characteristic appearance. Glenkiln Burn, S. Scotland; Upper Birkhill Shales. Coll. Lapworth.

f. Distal thecæ, preserved partly as a cast. Ibid.

region of the theca, and being slightly retroverted and twisted causes the plane of the apertural margin to lie somewhat obliquely with respect to the general trend of the polypary.

Description.—The polypary is commonly somewhat curved (with the thecæ on the concave margin except at the extreme proximal end), though short fragments appear fairly straight; it widens gradually throughout its length till the maximum breadth is attained.

The sicula has a length of 1 mm., reaching slightly beyond the level of the aperture of th. 1. The whole proximal end of the polypary strongly recalls that of *M. Becki*.

The thecæ of the distal end have a fairly long lobed region occupying about one-third of the breadth of the polypary. As a result of compression the ventral wall tends to show double curvature and the apertural margin appears often to be very oblique; the upper wall is, however, so rarely discernible that the thecæ when viewed *upside down* bear the strongest resemblance to those characteristic of a *Dicellograptus* or a *Monograptus* of the *argutus* type.

Affinities.—*Monog. runcinatus* resembles *M. Becki* very closely in its proximal portion; it, however, differs markedly in the characters of the distal thecæ, and this should render the separation of the two species comparatively easy.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. turriculatus*).

S. Scotland: Mount Benger; Eldinhope; Belcraig Burn, etc. *Wales:* Forge Corner, Conway; River Twymyn; Llanbrynmair; West side of Upper Quarry, 550 yds E. of Faches-gau Farm, etc., Pont Erwyd. *Lake District:* Browgill.

Associates, etc.—*Monog. runcinatus* is a fairly common fossil in the basement rocks of the Gala-Tarannon beds, where it occurs associated with *Rastrites maximus*, *R. Linnæi*, *M. turriculatus*, *M. nudus*, *M. dextrorsus*, *M. spiralis*, etc.

Collections.—Geological Survey of England and Wales, Fearnsides, Lapworth and the Authors.

Var. **pertinax,** var. nov. Plate XLV, figs. 3 *a—g*.

1906. *Monograptus runcinatus mut.*, Wood, Quart. Journ. Geol. Soc., vol. lxii, p. 644 *et seq.*

In addition to the typical forms of *M. runcinatus*, there have been found others which appear to differ mainly in being much stiffer and straighter. In addition,

Figs. 310 *a—c.*—*Monograptus runcinatus* var. *pertinax*, var. nov.

a. Proximal portion with sicula, partly in relief, partly a cast. Enlargement of part of Pl. XLV, fig. 3 *a*.
b. More distal thecæ, in relief; reverse aspect with apertural margins partly turned away. Enlargement of part of Pl. XLV, fig. 3 *b*.
c. Distal thecæ, in relief; obverse aspect, with apertural margins partly facing. Gelli-dywyll Stream, Llanbrynmair; Brynmair Beds. Coll. Wood.

Figs. 311 *a* and *b*.—*Monograptus Becki* (Barrande).

a. Proximal portion. Enlargement of part of Pl. XLV, fig. 4 *a*.
b. Distal thecæ, showing extreme retroversion of apertural regions. Enlargement of part of Pl. XLV, fig. 4 *d*.

too, the thecæ are less closely set in the proximal portion of the polypary, measuring ten in 10 mm. against eleven in *M. runcinatus* itself, while the thecal walls are as a rule more conspicuous.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. turriculatus*).

Wales: Gelli-dywyll Stream, below Farmhouse, and Gelli Stream, near Llanbrynmair. *Scotland:* Buckholmside, Galashiels.

Collections.—Geological Survey of Scotland, and Wood.

Monograptus Becki (Barrande). Plate XLV, figs. 4 *a—f*.

1850. *Graptolithus Becki*, Barrande, Grapt. de Bohême, p. 50, pl. iii, fig. 14.
1876. *Monograptus Becki*, Lapworth, Geol. Mag. [2], vol. iii, p. 500, pl. xx, figs. 2 *a*, *b*.

Polypary several cm. in length, arcuate or irregularly flexed proximally, widening very gradually from a slender thread-like proximal portion till a maximum breadth of 1 mm. is attained. Thecæ usually on concave margin, ten in 10 mm., of the *M. lobiferus* type.

Description.—The irregularly flexed or arcuate form of the polypary with the thecæ on the concave margin, and the persistently increasing breadth are characteristic of the species.

The sicula is unknown. The thecæ in the proximal portion are very slender, the only conspicuous feature being their lobes. The thecæ increase in size distally until they have a very characteristic shape, their outer walls forming an almost straight line down the polypary, broken only by the apertural lobes (Fig. 311 *b*). The lobes themselves are coiled completely round and are somewhat twisted, so that they closely resemble those of *M. lobiferus* though the adnate region of the thecæ is rather more conspicuous.

Affinities.—In the general form of the polypary and characters of the thecæ *Monog. Becki* shows some approximation to *M. retroflexus*, but the initial region is far more slender and thread-like. It also bears a certain amount of resemblance to *M. dextrorsus*, but differs in its more slender proximal termination, and to some extent also in the characters of the thecæ.

Horizon and Localities.—Gala-Tarannon Beds (zones of *M. turriculatus* and *M. crispus*).

S. Scotland: Meigle Quarry; Caddonfoot; etc. *Ireland:* Portaferry, Co. Down. *Wales:* River Twymyn, Llanbrynmair.

Associates, etc.—*Monog. Becki* seems to be rather a rare fossil in the zone of *M. crispus*, where it occurs associated with *M. crispus*, *M. exiguus*, *M. nudus*, *M. galaensis* and *M. Marri*. It is also found, but less commonly, in the zone of *M. turriculatus*.

Collections.—Belfast Natural History Museum, Swanston, Sedgwick Museum, Lapworth, and the Authors.

Monograptus exiguus (Nicholson). Plate XLVI, figs. 1 *a—d*.

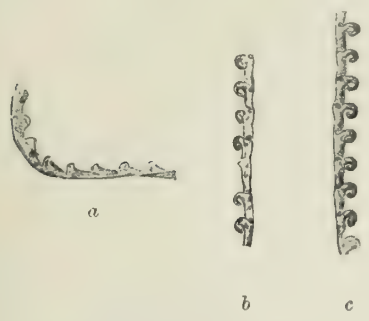
1868. *Graptolites lobiferus* var. *exiguus*, Nicholson, Quart. Journ. Geol. Soc., vol. xxiv, p. 533, pl. xix, figs. 27, 28.

1871. *Graptolithus plumosus*, Baily, Mem. Geol. Survey, Ireland, Sheet 49, 50, p. 23, figs. 1 *a*, *b*, *c*.

1876. *Monograptus exiguus*, Lapworth, Geol. Mag. [2], vol. iii, p. 503, pl. xx, fig. 6.

1892. *Monograptus exiguus*, Törnquist, Siljansområd. Grapt., ii, p. 25, pl. ii, fig. 22.

Polypary short, slender, arcuate, fish-hook like, with double curvature at the proximal end, and of approximately uniform breadth throughout, not exceeding ·5 mm. Thecæ on the concave margin, fourteen to twelve in 10 mm., small, of the general type of *M. lobiferus*, but with practically the entire apertural region coiled up into a dense lobe, occupying one-half of the total breadth of the polypary; overlap insignificant.



Figs. 312 *a—c.*—*Monograptus exiguus* (Nicholson).

a. Proximal fragment, showing sicula, but with thecæ poorly preserved. Portaferry, co. Down; Tarannon Beds. C. Il. Swanston, Belfast.

b. Distal thecæ in low relief. Enlargement of part of Pl. XLVI, fig. 1 *d*.

c. Distal thecæ, in full relief, showing the coiled lobes. Bont Green, River Twymyn, Llanbrynmair; Brynmair Beds. Coll. Wood.

Description.—The form of the polypary recalls that of *M. Nilssoni*, only on a smaller scale, the polypary rarely exceeding 3 cm. in length; the thecæ are on the concave margin except at the proximal end, where the curvature changes and the thecæ are for a short distance on the convex side. At the extreme proximal end the width of the polypary is about ·25 mm., but it widens rapidly to a maximum of ·5 mm., which is then maintained.

The sicula is small, about ·9 mm. in length, with th. 1 arising about one-third of the distance along its length.

The lobes are by far the most conspicuous portion of the thecæ, and in poorly preserved specimens are all that can be seen of the thecæ.

Affinities.—*Monog. exiguus* closely resembles *M. nodifer* when the latter is poorly preserved; for though the polypary in *M. nodifer* is commonly rather stiffer, the curvature less, and the increase in breadth more persistent, so that distal fragments are wider than any portions of *M. exiguus*, these are not matters readily discernible in poorly preserved specimens. The same difficulty applies to the thecæ. When preserved in full relief the thecæ of the two species are obviously distinct, those of *M. nodifer* having a more conspicuous adnate region, while there is a far greater degree of retroversion and torsion of the apertural region, so that the termination of the apertural region is turned upon itself once more. There may be something of the same kind in a few of the most distal thecæ of *M. exiguus*, but it is far less conspicuous than in *M. nodifer*, and in many cases it would seem to be impossible to detect it at all. In poorly preserved specimens the thecæ appear to resemble each other very closely, and there is little to distinguish the two species beyond the more conspicuous and persistent widening of the polypary of *M. nodifer* compared with the general uniformity in breadth of that of *M. exiguus*.

From all other *Monograpti* the form of the polypary in *M. exiguus* and the lobed nature of the thecæ are sufficient to distinguish it.

Horizon and Localities.—Gala-Tarannon Beds (zones of *M. turriculatus* [upper part only] and *M. crispus*).

S. Scotland: Caddonfoot; Meigle Quarry; Glendearg; Grieston Burn; Douglas, near Tushielaw, etc. *Wales:* Tarannon River, etc; Llanystwmdwy, near Criccieth; Forge Corner, Conway. *Ireland:* Portaferry; Tieveshilly. *Lake District:* Great Rundle Beck; Faith's Gill, Sedbergh; Browgill, etc.

Associates, etc.—*Monog. exiguus* occurs in profusion in beds of Gala-Tarannon age, especially in the zone of *M. crispus*, where it is commonly associated with *M. crispus*, *M. discus*, and *M. Marri*; it also occurs, but less abundantly, in the upper parts of the lower zone of *M. turriculatus* associated with *M. turriculatus*, *M. runcinatus*, *M. nudus*, *Rastrites Linnæi*, etc.

Collections.—Sedgwick Museum, Geological Survey of Scotland, Belfast Natural History Museum, F. G. Black of Cambridge, Lapworth, and the Authors.

Monograptus nodifer, Törnquist. Plate XLVI, figs. 2 *a*—*d*.

1881. *Monograptus nodifer*, Törnquist, Några Grapt. Dalarne, p. 436, pl. xvii, figs. 2 *a*—*c*.
1882. *Monograptus nodifer*, Tullberg, Skånes Grapt., vol. ii, p. 25, pl. ii, figs. 30—32.
1892. *Monograptus nodifer*, Törnquist, Siljansområd. Grapt., ii, p. 26, pl. ii, figs. 23—28.

Polypary small, slender, arcuate, with double curvature at the proximal end, increasing gradually in breadth till a maximum of ·9 mm. is attained. Thecæ on the concave margin, twelve to ten in 10 mm., of the general type of *M. lobiferus*, but with greater retroversion and torsion of the whole apertural region, the resulting lobe occupying proximally fully one-half of the breadth of the polypary, but distally rather less.

Description.—The polypary is curved in a manner which strongly resembles that of *M. exiguus*, though as a rule the flexure is somewhat stiffer and the polypary somewhat larger, specimens of 4—5 cm. in length being of fairly common occurrence. The polypary widens more gradually than *M. exiguus*, and attains a greater breadth, so that fragments from the proximal portion may actually be narrower than corresponding portions of that species.

Figs. 313 *a*—*d*.—*Monograptus nodifer*, Törnquist.

a. Complete specimen, in partial relief, showing sicula. River Twymyn, near Llanbrynmair; Brynmair Beds. Coll. Wood.

b. Distal thecæ, in partial relief, showing well-marked lobe. Enlargement of part of Pl. XLVI, fig. 2 *c*.

c. Small fragment, in full relief. Llanystwmdwy, near Criccieth. Coll. Fearnsides.

d. Fragment in full relief, showing the "double fold" appearance and "excavation" characteristic of this form. Llanystwmdwy. Coll. Fearnsides.

The sicula is small, measuring ·9 mm. in length, th. 1 arising from near its base.

The thecæ when compressed usually recall those of *M. runcinatus* as respects their adnate region, the ventral wall not infrequently presenting the appearance of expanding in the direction of the apertural lobe of the thecæ next below; in specimens preserved in relief, however, this is not such a conspicuous feature.

The appearance described by Törnquist as a "double fold" is visible in many of our specimens preserved in relief, but appears to us to be a consequence of the extreme torsion of the apertural region, to such an extent indeed, that the appearance presented almost suggests an excavation of the upper part of the ventral wall for its reception.

Affinities.—As will be gathered from the above description, *Monog. nodifer* presents many points of resemblance to *M. exiguus*, and, in fact, in poorly preserved specimens is almost indistinguishable unless the more gradual and persistent widening of the polypary can be made out. In well-preserved specimens there is a greater amount of retroversion and torsion of all the thecæ of *M. nodifer*, only a few of the most distal thecæ of *M. exiguus* showing anything of the kind, and then in a less degree, so that in such specimens the distinction is comparatively easy.

Horizon and Localities.—Gala-Tarannon Beds (zones of *M. crispus* and *M. turriculatus*).

S. Scotland: Grennan Quarry, Drummore, Mull of Galloway; Hill End, N. of Clovenfords, Melrose, etc. *Wales:* River Twymyn, Llanbrynmair; Forge Corner,

Conway; Bank of Afon Gyffin, opposite Conway Castle; Llanystwmdwy; Cefn Hendre Quarry, about 150 yds. E. of Farm, 1½ miles E. of Aberystwyth.

Associates, etc.—*Monog. nodifer* is not a very abundant fossil in Britain, but it has been found at the base of the Gala beds associated with *M. turriculatus*, *M. nudus*, *M. runcinatus*, and *Rastrites maximus*, and also at a higher horizon with *M. exiguus* and *M. crispus*.

Collections.—Geological Survey of England and Wales, Sedgwick Museum, Fearnsides, Lapworth, and the Authors.

Monograptus crispus, Lapworth. Plate XLV, figs. 6 *a*—*f*.

1876. *Monograptus crispus*, Lapworth, Geol. Mag. [2], vol. iii, p. 503, pl. xx, fig. 7.

1907. *Monograptus gemmatus*, Törnquist, *Rastrites* and allied species of *Monograptus*, Lund. Univ. Årsskr., N.S., afd. 2, iii, no. 5, p. 21, pl. iii, figs. 26, 27.

Polypary slender, 2—3 cm. in length, distal portion broadly incurved, proximal portion strongly recurved, very slender but widening rapidly throughout to a maximum breadth of rather less than 1 mm. Thecæ seven to nine in 10 mm., of the general type of those of *M. lobiferus*, but with even more of each theca involved in the conspicuous lobe. Overlap insignificant.

Description.—The polypary when complete has the form of a note of interrogation, the thecæ being first upon the convex and then upon the concave side. The very slender, recurved proximal portion is, however, but rarely preserved; it is, as a rule, composed of the sicula (with a length of about 1 mm.), and two or three extremely slender thecæ, of which the earliest arises close to the apex of the sicula.

FIGS. 314 *a*—*c*.—*Monograptus crispus*, Lapworth.

a. Proximal portion, showing sicula. Enlargement of part of Pl. XLV, fig. 6 *c*.
b. Median portion, showing change in character of the thecæ. Enlargement of part of Pl. XLV, fig. 6 *e*.
c. Distal thecæ, showing lobed apertural regions. Meigle Quarry, Galashiels; Gala Beds. Coll. Lapworth.

The thecæ differ somewhat in appearance in different portions of the polypary. Of the adnate region of the theca in the proximal portion scarcely anything can be seen, the theca appearing to consist almost entirely of lobe, occupying three-fourths or more of the breadth of the polypary; distally, however, the adnate region becomes somewhat more conspicuous, and rather more than one-half of the thecal length is involved in the lobe, which is still the most conspicuous feature of the slender polypary, and occupies fully two-thirds of its total breadth. These distal thecæ

show more conspicuous torsion than do those of the proximal portion, and, in addition, they are more closely set, measuring nine in 10 mm. as compared with seven in the proximal part.

Affinities.—The form of the polypary, its rapid increase in breadth, and the strongly lobed thecæ render the species unique amongst the *Monograpti*.

Horizon and Localities.—Gala-Tarannon Beds (zone of *M. crispus*).

S. Scotland: Meigle Quarry, Galashiels; Gala Hill; Grieston Burn; Caddonfoot; Cauldshields, etc. *Wales:* Tarannon River; Gelli Stream, near Llanbrynmair; South of Llwyn-ffynon, etc.; Forge Corner, Conway. *Lake District:* Great Rundle Beck. *Ireland:* Portaferry; Tieveshilly.

Associates, etc.—*Monog. crispus* is fairly common in, and restricted to, the zone of *M. crispus*, associated with *M. discus*, *M. exiguus*, *M. Murri*.

Collections.—Belfast Natural History Museum, Sedgwick Museum, Black, Lapworth, and the Authors.

Monograptus flagellaris, Törnquist. Plate XLVI, fig. 3.

1892. *Monograptus flagellaris*, Törnquist, Siljansområd. Grapt., ii, p. 42, pl. iii, figs. 31–33.

Polypary small, of conical spiral form, with the thecæ first on the convex and then on the concave margin, increasing rapidly in breadth to a maximum of 1 mm. Thecæ twelve in 10 mm., almost subtriangular, with apertural region bent into a closely-coiled and twisted lobe, which occupies about seven-tenths of the total breadth of the polypary.

Description.—The twisted form of the polypary, which is invariable, seems to be characteristic of this species, which never exceeds 2 cm. in length, and increases rapidly in breadth throughout that distance.

Fig. 315.—*Monograptus flagellaris*, Törnquist.

Enlargement of Pl. XLVI, fig. 3.

The thecæ are of the same type throughout, though the lobate character of the apertural region becomes steadily more pronounced towards the distal end. The torsion of the thecal axis is indicated in the front view and becomes even more obvious when the polypary is viewed from the back, when scarcely any indication of the lobe is seen.

Affinities.—The rapidly widening polypary, its peculiar form, and the characteristic thecæ are together sufficient to make the identification of *Monog. flagellaris* comparatively easy. There is, however, an obvious approximation as regards the shape of the thecæ to the members of the *M. convolutus* Group.

Horizon and Localities.—Gala Beds.
S. Scotland: Blythe Water, Lauder.
Associates.—Unknown.
Collection.—Geological Survey of Scotland.

Monograptus capillaceus, Tullberg. Plate XLVI, figs. 4 *a—d.*

1883. *Monograptus capillaceus*, Tullberg, Skånes Grapt., ii, p. 24, pl. ii, figs. 28, 29.

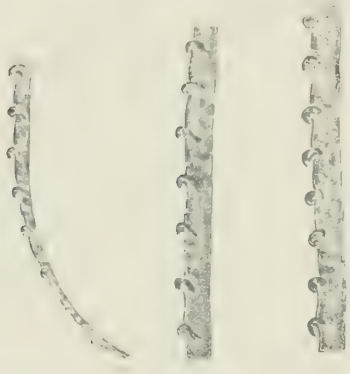
Polypary several cm. in length, conspicuously flexed, generally incurved distally and recurved proximally, widening persistently from a very slender proximal portion to a maximum breadth of about 1 mm. Thecæ eight to ten in 10 mm., of the general type of those of *M. lobiferus*, but with only a small fraction of the total thecal length involved in the lobe, which only occupies one-fifth of the total breadth of the polypary. Overlap insignificant.

Description.—The polypary is usually from 6—8 cm. in length and occasionally even more. British examples are frequently rather more arcuate distally than is the case with the Swedish specimens, some individuals making a more or less complete **S**-bend. The polypary widens persistently throughout its length, fairly rapidly in the extreme proximal portion but to so slight a degree distally that fragments of the distal portion seem to have an approximately uniform breadth.

The sicula is small, not exceeding 1 mm. in length, and th. 1 arises from it shortly above its aperture, so that the apertural region of the sicula alone forms the termination of the polypary, which is very slender, not exceeding ·3 mm. in breadth.

The proximal thecæ are longer, more slender, and more distant than the distal ones, measuring only eight in 10 mm. The proportion of the apertural region of each theca involved in the isolation and retroversion is, in this species, so small that the lobes project but slightly from the general line of the polypary; the ventral walls form an almost straight line, broken only by the lobes; the upper walls are very short.

Figs. 316 *a—c.*—*Monograptus capillaceus*, Tullberg.



a. Proximal portion, showing sicula. Enlargement of specimen on same slab as Pl XLVI, fig. 4*d*.
b. Distal thecæ. Enlargement of part of specimen on same slab as Fig. 316 *a*.
c. Distal thecæ, showing lobed apertural regions. Milk Water at Milkbridge, three miles S. of Lockerbie, S. Scotland. Geological Survey of Scotland.

Affinities.—*Monog. capillaceus* approaches most closely to *M. retroflexus* in its general form, but in this latter species the polypary is much more slender, and does not widen throughout like *M. capillaceus*, while the lobe is more tightly coiled.

Horizon and Localities.—Wenlock Shales (zone of *M. riccartonensis*).

S. Scotland: Milk Water; Hyndlee Burn, etc. *Wales:* Newbridge-on-Wye; River Wye, near Builth Bridge; behind Grove Cottages, Rhayader Road, near Builth, etc. *Shropshire:* Walcot Quarry, Chirbury. *Lake District:* Rawthey Bridge.

Associates, etc.—*Monog. capillaceus* is a fairly abundant fossil in the Lower Wenlock Shales, where it occurs in the zone of *M. riccartonensis*, associated with *M. riccartonensis* and *M. priodon*.

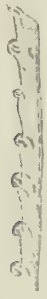
Collections.—Geological Survey of Scotland, Watney and Welch, the Authors.

Monograptus retroflexus, Tullberg. Plate XLVI, figs. 5 *a*—*c*.

1882. *Monograptus retroflexus*, Tullberg, Skånes Grapt., p. 25, pl. i, figs. 18—20.

Polypary slender, arcuate, with abruptly reflexed proximal portion, widening very rapidly in the initial region and having an average uniform breadth (after the first few mm.) of ·75 mm. Thecæ ten in 10 mm., usually on the concave margin except near proximal end; slender tubes with insignificant overlap, of the general type of those of *M. lobiferus*, with the apertural region bent back completely upon itself, but with a very small fraction of the thecal length involved in the lobe, which is relatively conspicuous, occupying from one-half to one-third of the total breadth of the polypary.

Fig. 317.—*Monograptus retroflexus*, Tullberg.



Distal thecæ. Same locality as Pl. XLVI, figs. 5 *a*—*c*.

Description.—Fragments only of this species are known in Britain, but they are sufficiently characteristic to render the identification certain.

The thecæ are usually well seen, and their ventral walls show decided curvature.

Affinities.—The general form of the polypary and the characters of the thecæ approximate perhaps more closely to those of *M. capillaceus* than to those of any other graptolite, but the species may be distinguished by its more rapid widening and more slender average width, whilst the thecal lobe is more tightly coiled.

Horizon and Localities.—Wenlock Shales (zone of *Cyrtog. rigidus*).

Welsh Borderland: Quarry near Nant Prophwyd, Builth Road; Dulas Brook, Builth Road; Kingswood, S.W. of Long Mountain.

Associates, etc.—*Monog. retroflexus* is a somewhat rare fossil in the Upper Wenlock Shales, occurring, so far as our knowledge goes, exclusively in the zone of

Cyrtog. rigidus, where it is found with the zone fossil, *M. dubius*, *M. vomerinus* and *M. Flemingii* var. *primus*.

Collection.—Elles.

Monograptus dextrorsus, Linnarsson. Plate XLVI, figs. 7 *a—d*.

1881. *Monograptus dextrorsus*, Linnarsson, Geol. Fören. i Stockholm Förhandl., p. 511, pl. xxiii, figs. 1—7.

Polypary slender, arcuate or flexed, several cm. in length, of approximately uniform breadth in the distal portion but becoming still more slender towards the proximal end. Thecæ seven to eight in 10 mm., on the concave margin; narrow, with concave outer walls, each theca having the apertural region abruptly folded upon itself to form a peculiar twisted short lobe.

FIGS. 318 *a—e.*—*Monograptus dextrorsus*, Linnarsson.

a. Slender proximal fragment. Afon Cwm Calch, near Talerddig; Talerddig Beds. Coll. Wood.
b. Distal thecæ showing various appearances. On same slab as Pl. XLVI, fig. 7 *c*.
c. Specimen preserved in scalariform view, showing apertures. Same locality as Figs. 318 *a*, etc.
d. Wider specimen, showing sicula, probably referable to this species. Llanystwmdwy. Coll. Fearnsides.
e. Distal thecæ presented in profile view. Belcraig Burn, near Moffat; Birkhill Shales (Band of *Rastrites maximus*). Coll. Elles.

Description.—The polypary usually shows marked concave curvature, but there is some variation in this respect, some specimens showing a tendency to convexity in the neighbourhood of the proximal end. The maximum breadth is about 1 mm. but the extreme proximal portion is very slender.

The sicula measures 1·4 mm., and extends slightly beyond the aperture of th. 1.

The thecæ are very characteristic, owing to the peculiar character of the apertural lobes resulting from the abrupt folding of the isolated apertural region upon itself, so that the twisted lobe appears to rest as it were upon the body or adnate region of the theca; somewhat after the manner of a cup and ball. This, however, is only shown in one aspect of the polypary (obverse); if viewed from the reverse side often no trace of the twisted lobe can be detected, and the theca seems almost to have a smooth even edge, which is very deceptive.

Affinities.—So far as we are aware *Monog. dextrorsus* stands alone amongst the *Monograpti* in the possession of these peculiarly shaped thecæ, but in the reverse view they may easily be confounded with the thecæ of those species which have 'tagged' apertural margin such as *M. intermedius*. The curvature of the polypary, however, is different in almost all cases.

Horizon and Localities.—Gala-Tarannon Beds (zones of *M. turriculatus*, *M. crispus*, *M. griestoniensis*).

Lake District: Swindale. *Wales:* Forge Corner, Conway; Afon Gyffin opposite Conway Castle; Llanystwmdwy, near Criccieth; Tarannon River; Afon Cwm Calch, Talerddig. *S. Scotland:* Belcraig Burn; Clanyard Bay, near Drummore, Mull of Galloway; Darnick Bridge, near Melrose.

Associates, etc.—*Monog. dextrorsus* is fairly abundant in a fragmentary condition in the Lower Gala beds (Tarannon) associated with *M. Marri*, *M. exiguus*, etc., in the zone of *M. crispus*; it occurs also in the preceding zone with *M. Halli*, *M. runcinatus*, *M. nudus* and *Rastrites maximus*, and at the top of the succeeding zone of *M. griestoniensis* with the zone fossil, *M. discus* and *M. priodon*.

Collections.—Sedgwick Museum, Geological Survey of Scotland, Lapworth, and the Authors.

Monograptus remotus, sp. nov. Plate XLVI, figs. 9 *a*, *b*.

Polypary slender, arcuate, of unknown length, widening very gradually from the initial region to a maximum breadth of ·6 mm., which is thereafter approximately maintained. Thecæ on the convex margin, three to four in 10 mm., becoming increasingly remote distally; slender, of the general type of those of *M. lobiferus*, but far longer, and with only the extreme apertural region involved in the lobe; overlap insignificant.

Fig. 319.—*Monograptus remotus*, sp. nov.

Enlargement of part of Pl. XLVI, fig. 9 *b*, showing the characteristic increase in the length of successive thecæ.

Description.—The polypary is arcuate, with the thecæ on the convex margin. The maximum breadth is only attained opposite the lobate apertural region of the thecæ; elsewhere it does not exceed ·3 mm. and is uniform, the ventral walls of successive thecæ forming a straight line which is only broken by the projecting lobes.

The thecæ are very long uniformly narrow tubes, with only the extreme apertural region coiled up to form the lobe; these lobes are very remote from each other, and their remoteness increases distally, which is (so far as is known at present) a unique character among Graptoloidea.

Affinities.—The long thecæ of *Monog. remotus* with their remote apertural lobes appear to be so peculiar as to enable the polypary to be recognised with ease. The thecæ are somewhat similar to those of *M. Barrandei* but far more remote, while the curvature of the polypary is different.

Horizon and Locality.—Wenlock Beds.
S. Scotland.—Rig Burn, River Esk, 6 miles W.N.W. of Langholm.
Associates, etc.—Unknown.
Collection.—Geological Survey of Scotland.

V. (*b*) : *Monograpti* with lobed thecæ in which the polypary has ventral curvature.

Monograptus Barrandei (Suess). Plate XLVI, figs. 6 *a*, *b*.

1851. *Graptolithus Barrandei*, Suess, Böhm. Grapt., p. 126, pl. ix, fig. 12.
1876. *Monograptus Barrandei*, Lapworth, Geol. Mag. [2], vol. iii, p. 502, pl. xx, figs. 5 *a*—*d*.

Polypary several cm. in length, very slender, arcuate, with an average breadth of about ·5 mm. Thecæ on the concave margin, seven to eight in 10 mm., long slender tubes with apertural extremity coiled into a conspicuous lobe which occupies about three-fourths of the total breadth of the polypary.

Fig. 320.—*Monograptus Barrandei* (Suess).

Enlargement of part of counter-impression of Pl. XLVI, fig. 6 *a*, showing the lobed apertural regions.

Description.—The polypary of *Monog. Barrandei* is only known in a fragmentary condition and details regarding the proximal end are obscure. The thecæ are always on the concave side so far as known, and there is a marked increase in breadth opposite the apertural lobes, the polypary measuring fully ·5 mm. at these points, whereas elsewhere the dimensions do not exceed ·3 mm. The ventral walls of the thecæ tend to run in an almost straight line broken only by the projecting lobes.

Affinities.—*Monog. Barrandei* differs from the other slender-lobed *Monograpti* mainly in the curvature of the polypary, and the more conspicuous lobes.

Horizon and Localities.—Gala Beds (lower zones).

S. Scotland : Waterfall, Main Linn, Dobb's Linn; Caddonhead; Buckholm; Meigle. *Ireland :* Tieveshilly, Co. Down.

Associates, etc.—*Monog. Barrandei* is found with *M. Becki* in the lower zones of the Gala beds.

Collections.—Geological Survey of Scotland, and Lapworth.

Monograptus knockensis, sp. nov. Plate XLVI, figs. 8 *a*, *b*.

Polypary of unknown length, straight or with very slight curvature, having the thecæ on the convex margin, and with an average maximum breadth

of 1·5 mm. opposite the thecal apertures. Thecæ seven in 10 mm., with the apertural region coiled tightly upon itself almost in a horizontal plane so that the apertural margin faces the adnate region, the lobe thus formed involving fully one-half the thecal length, and occupying two-thirds of the breadth of the polypary.

Description.—The polypary is only known in a fragmentary condition, but is sufficiently characteristic to render its separation from all other *Monograpti* easy. It was noted long ago by Nicholson and Marr as a new species, but never described by them. The total breadth of the polypary including the thecal lobes is 1·5 mm., but elsewhere the width does not exceed ·5 mm.

FIGS. 321 *a* and *b*.—*Monograptus knockensis*, sp. nov.

a. Distal thecæ, showing various appearances presented by the lobes. Enlargement of part of Pl. XLVI, fig. 8 *b*.

b. Counter impression of part of same specimen.

The thecæ are distant, their ventral walls show concave curvature, and the lobed apertural region is disproportionately large, and is so closely coiled upon itself in a horizontal plane that the apertural margin lies parallel to the dorsal wall of the polypary. In the reverse aspect the lobes are practically concealed so that it is clear that there is much torsion of the whole apertural region of each theca, and even in the obverse aspect the same is suggested by the variation in the position of the lobe.

Affinities.—The isolation of the theca, and the unusually large size of the lobed apertural region render the species separable from all others in the group to which it belongs except *M. lobiferus* itself, and from this its distant lobes are sufficient to distinguish it.

Horizon and Locality.—Tarannon Beds (Browgill beds), zone of *M. crispus*.

Lake District: Knock, Edenside.

Collection.—Dr. J. E. Marr.

V. (*c*) : *Monograpti* with lobed thecæ in which the polypary has dorsal curvature.

Monograptus Clingani (Carruthers). Plate XLVI, figs. 11 *a—f*.

1868. *Graptolithus Clingani*, Carruthers, Geol. Mag., vol. v, p. 127, pl. v, figs. 19 *a*, *b*.

1876. *Monograptus Clingani*, Lapworth, Geol. Mag. [2], vol. iii, p. 501, pl. xx, figs. 3 *a—c*.

Polypary several cm. in length, fairly robust, arcuate or straight distally, with broadly recurved proximal portion, widening quickly from an initial breadth of ·8 mm. to a maximum of about 1·5 mm. Thecæ on the convex margin,

twelve to seven in 10 mm., of the general type of those of *M. lobiferus*, but with only one-half to one-third of the thecal length involved in the formation of the lobe, which occupies from one-half to two-thirds of the breadth of the polypary; the apertural margin faces obliquely downward and inward. Overlap slight.

Description.—The polypary must have attained several cm. in length; fragments of the proximal portion are, however, of commonest occurrence, and are far more easily identifiable than those of the distal portion; they are all robust.

The sicula has a length of 1·2 mm. and reaches to the level of the top of th. 1.

FIGS. 322 *a* and *b*.—*Monograptus Clingani* (Carruthers).

a. Proximal portion, showing sicula. Duffkinnel, near Moffat; Birkhill Shales. Coll. Lapworth.
b. Distal thecæ, somewhat compressed. Dobb's Linn; Upper Birkhill Shales. Coll. Elles.

The thecæ of the proximal portion do not as a rule exhibit so much retroversion of the apertural region as those of the maturer parts of the polypary, in fact they frequently appear to possess the hook characteristic of the group of *M. priodon* rather than the lobe of the group of *M. lobiferus*. Distally, however, the amount of retroversion increases till the thecal angle exceeds 180°, and the lobate character is more definite, though it is always less pronounced than in the more typical members of the group. In this respect the mature thecæ show a decided resemblance to those of *M. communis* (group of *M. convolutus*), though in the latter case the lobate character is less significant. The thecæ appear to have diminished somewhat rapidly in breadth in their apertural regions, which exhibit an amount of torsion sufficient to cause all the actual apertural margins to face in one direction, either towards, or away from, the observer. Thus after compression there is frequently seen a view in which the adnate regions of the thecæ are very conspicuous, while the isolated apertural regions are visible merely as a fringe of hooks, or even completely embedded in the rock.

Affinities.—In respect of the shape of the polypary *Monog. Clingani* approaches both *M. millepeda* and *M. communis*, from either of which species it may be readily distinguished by its far more robust proximal portion. As respects the distal thecæ *Monog. Clingani* resembles *M. communis* more closely than any other form, but may be distinguished by the thecæ being larger and having a greater fraction of the thecal length involved in the lobe, which also shows a greater amount of retroversion.

Horizon and Localities.—Llandovery (zone of *M. convolutus*, especially *M. Clingani* band).

S. Scotland: Dobb's Linn; Belcraig Burn; Moory Syke; Whitehope Burn,

etc. *Lake District:* Skelgill. *Ireland:* Coalpit Bay, Donaghadee. *Wales:* E. side of Quarry, N.E. Fagwr-fawr, 2 miles E.N.E., Pont Erwyd; S. side of Quarry, 270 yards N.E. Gwen-ffrwd Uchaf Farm.

Associates, etc.—*Monog. Clingani* occurs in some profusion in a band near the top of the zone of *M. convolutus*, occurring so plentifully in some localities as to make the separation of the bed in which it is met with a matter of comparative ease. It is commonly found with *M. communis*, *M. convolutus*, *M. lobiferus*, *M. decipiens*, *M. involutus*, *Orthog. bellulus*, and *Climacog. scalaris*.

Collections.—Geological Survey of Scotland, Geological Survey of England and Wales, British Museum (Natural History), Sedgwick Museum, Belfast Natural History Museum (Bullock Collection), Lapworth, and the Authors.

Monograptus millepeda (M'Coy). Plate XLVI, figs. 10 *a*—*d*.

1850. *Graptolites millepeda*, M'Coy, Ann. Mag. Nat. Hist. [2], vol. vi, p. 270.
1854. *Graptolites millepeda*, Sedgwick and M'Coy, Brit. Pal. Rocks and Fossils, p. 5, pl. i B, fig. 6.
1876. *Monograptus lobiferus*, Lapworth, Geol. Mag. [2], vol. iii, p. 499, pl. xx, fig. 1 *c*.
1892. *Monograptus lobiferus*, Törnquist, Siljansområd. Grapt., ii, p. 18, pl. i, fig. 36, pl. ii, fig. 4.

Polypary several cm. in length, arcuate, with abruptly involute proximal portion, widening rapidly to a maximum breadth of 1·5 mm., which is then approximately constant. Thecæ on the convex margin, fourteen to ten in 10 mm., of the general type of those of *M. lobiferus*, but with rather less of the theca involved in the lobation, and with a rather less tightly coiled lobe.

FIGS. 323 *a*—*c*.—*Monograptus millepeda* (M'Coy).

a. Proximal portion with sicula, in low relief. Rheidol Gorge, 440 yards S.S.E. of Bryn-chwîth, Pont Erwyd. Geol. Survey England and Wales.
b. Proximal thecæ in partial relief. Llanystwmdwy, near Criccieth. Coll. Fearnsides.
c. Distal thecæ. Parys Mount, Anglesea. Geol. Survey of England and Wales.

Description.—The polypary is always strongly curved, and in the proximal portion is conspicuously involute, after the manner of *M. cyphus*, but somewhat more abruptly. It widens quickly from an initial breadth of about ·5 mm. to a maximum of 1·5 mm.

The sicula has a length of fully 1 mm.

The thecæ face obliquely inwards, and from specimens preserved in relief it is clear that there was considerable torsion of the whole apertural region; the fraction of the theca involved in the formation of the lobe never exceeds one-half of its total length, and occupies about five-sevenths of the total breadth of the polypary.

Affinities.—*Monog. millepeda* has occasionally been confused with *M. lobiferus* or

M. Clingani. From *M. lobiferus* it differs in the strongly recurved proximal end and in the characters of the thecæ, the lobe being relatively less conspicuous and involving a smaller fraction of the total thecal length. From *M. Clingani*, with which it agrees in the curvature of the proximal portion, it differs conspicuously in the characters of the thecæ in that portion. There is more resemblance in the thecæ of the distal portions, though those of *M. millepeda* are set at a higher angle, giving rise to a different appearance, especially after compression.

Horizon and Localities. — Llandovery (zone of *M. gregarius*, sub-zone *M. argenteus*).

S. Scotland: Dobb's Linn; Lockerbie, etc. *Wales:* Parys Mountain, Anglesea; Rheidol Gorge, 440 yards S.S.E. Bryn-chwîth. *Lake District:* Skelgill.

Associates, etc.—*Monog. millepeda* occurs at the top of the zone of *M. gregarius* in the *M. argenteus* sub-zone, where it is found with *M. gregarius*, *M. leptotheca*, *M. triangulatus*, *Glyptog. tamariscus*, *Climacog. Hughesii*, *Petalog. minor*, etc.

Collections.—Geological Survey of England and Wales, British Museum (Natural History), Jones, Fearnsides, Sedgwick Museum, Lapworth, and the Authors.

Group VI.

Monograpti in which the mature thecæ are triangular or conical in form with reflexed apertural margins.

In the *Monograpti* included in this group the tendency of the thecæ to *isolation* is much more completely carried out than in any of the groups already described, while at the same time the tendency to *lobation* is less, being relatively insignificant.

Thecæ of two types are of fairly common occurrence, those of the proximal portion of the polypary showing a tendency to a still greater degree of isolation than those of the maturer portion. Sometimes, indeed, the isolation is so conspicuous as to approach that characteristic of the members of the group next to be described (*Rastrites*). Thus there are forms like *M. convolutus* and *M. triangulatus*, in which the proximal thecæ appear to be completely isolate linear tubes with only the merest fraction of their apertural extremities reflexed. This reflexed part is so short as to constitute a distinct "*barb*" rather than a "*lobe*"; and may be open (*M. urceolus*) or more or less completely closed (*M. triangulatus*).

The distal thecæ, when flattened, are, as a rule, more or less broadly triangular in form, with usually only a small fraction included in the formation of the terminal apertural barb. In general, fully three-fourths to seven-eighths of the upper wall of the theca is free, and of this free portion only a fraction ranging from one-fifth to one-third is involved in the barb.

Some forms, indeed, like *M. communis*, in which one-third of the total thecal

length is involved in the barb, approach rather in this respect some of the members of the preceding group (such as *M. Clingani*), but show always too high a proportion of isolation for inclusion in that group, and they are, therefore, considered as being rather closer to the members of Group V.

The polyparies are almost always curved, but the amount of curvature varies greatly.

The species included in this group may be subdivided into sections and subsections according to the uniform or bi-form type of the thecæ, and the curvature of the polypary.

A. With *bi-form* thecæ.

(*a*) The polypary has spiral curvature. Type : *Monograptus convolutus. M. decipiens, M. urceolus.*

(*b*) The polypary has dorsal curvature. Type : *Monograptus triangulatus. M. triangulatus* var. *major, M. raitzhainiensis, M. denticulatus.*

B. With *uniform* thecæ.

(*a*) The polypary has spiral curvature. Type: *Monograptus spiralis. M. proteus, M. delicatulus, M. involutus, M. circularis.*

(*b*) The polypary has dorsal curvature. Type : *Monograptus communis. M. communis* var. *rostratus, M. fimbriatus*, var. *similis, M. planus, M. intermedius.*

(*c*) The polypary has dorsi-ventral curvature. Type : *Monograptus* cf. *elongatus.*

VI. A. (*a*) : *Monograpti* in which the thecæ are bi-form and the polypary has spiral curvature.

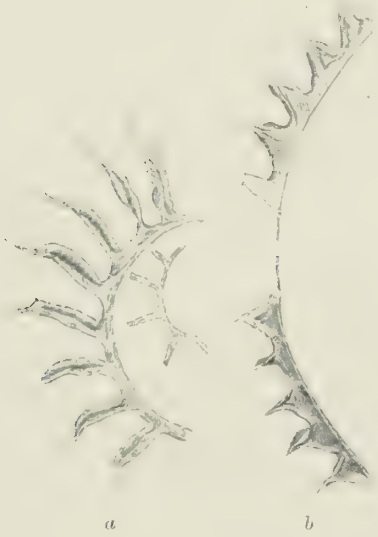
Monograptus convolutus (Hisinger). Plate XLVII, figs. 1 *a—d.*

1837. *Prionotus convolutus*, Hisinger, Leth. Suec. Supplem., p. 114, pl. 35, fig. 7.
1868. *Graptolithus convolutus*, Carruthers, Geol. Mag., vol. v, p. 127, pl. v, fig. 1.
1881. *Monograptus convolutus*, Tullberg, Grapt. desc. by Hisinger, p. 14, pl. ii, figs. 13—16.
1892. *Monograptus convolutus*, Törnquist, Siljansområd. Grapt., ii, p. 30, pl. iii, figs. 5—11.
1897. *Monograptus convolutus*, Perner, Grapt. de Bohême, p. 13, pl. xii, figs. 26—29 ; pl. xiii, fig. 41, text-fig. 10.

Polypary often of considerable size and length, coiled into a flat spiral, except at the distal extremity which is merely arcuate ; slender, but widening gradually for the first few whorls, then maintaining a constant breadth of 3 mm. for the remainder of its extent. Thecæ ten to seven in 10 mm., on the convex margin ; those of the proximal portion of the narrow, isolate *Rastrites* type, those of the distal portion triangular, in contact only,

with fully four-fifths of length free, of which the outermost fifth is involved in reflexion to form a small inconspicuous barb, or this barb may appear to be more or less completely replaced by a distinct spine.

Description.—Monog. convolutus presents its most typical appearance when seen as a plane flat spiral; the mode of preservation, however, has sometimes caused the convolutions to be somewhat irregular in form, and at the distal end the whorls seem to cease and the polypary is prolonged with a merely arcuate curve; fragments showing this are of fairly frequent occurrence.



Figs. 324 *a* and *b*.—*Monograptus convolutus* (Hisinger).

a. Proximal portion, showing parts of two whorls. Enlargement of part of Pl. XLVII, fig. 1 *b*.

b. Distal thecæ, in relief, but somewhat embedded so that the apertural margins are partially concealed. E. side of Quarry, N.E. of Fagwr-fawr Farm, Pont Erwyd. Geol. Survey of England and Wales.

The best British specimen known to us is unusually large; it exhibits five whorls, but is not complete proximally, though it clearly shows the *Rastrites*-like character of the earlier thecæ. This specimen has a diameter of 7·2 cm., and the whole of the first whorl and half the second bear thecæ of the *Rastrites* type, long linear tubes with slightly barbed apertural terminations, these tubes being twice as long as the interspaces which separate them. The thecæ gradually lose their linear character, becoming broader in the adnate region, and finally are distinctly triangular in form with definitely spined apertural terminations, resembling in this respect the distal thecæ of *M. Sedgwickii*, though distinctly more triangular in shape and more isolate. The number of thecæ in the proximal portion which show the *Rastrites* form would appear to vary somewhat, though there are always sufficient for this to be a characteristic feature of the polypary.

Affinities.—Monog. convolutus resembles *M. spiralis* in its general shape and in the general characters of the distal thecæ, but the proximal thecæ with their *Rastrites*-like form are quite different, and the whole polypary is more slender than *M. spiralis*, which widens persistently throughout its extent. As regards the general characters of its thecæ *Monog. convolutus* approaches *M. triangulatus*, but its convolute shape should serve to distinguish it. From *M. circularis*, which it resembles in general form, it may be separated by the characters of the thecæ.

Horizon and Localities.—Llandovery (zone of *M. convolutus*).

S. Scotland: Dobb's Linn; Belcraig Burn; Lockerbie; Head of Pishnack Burn, Wee Queensbury, etc. *Lake District*: Skelgill; West side Long Sleddale. *Ireland:* Coalpit Bay, Donaghadee. *Wales:* River Twymyn, Llanbrynmair; fifty yards E. of fence, 270 yards N.E. of Gwen-ffrwd Uchaf Farm; W. and E. side Old Quarry, N.E. Fagwr-fawr Farm, 2 miles E.N.E. of Pont Erwyd.

Associates, etc.—*Monog. convolutus* is a fairly common fossil, though often only in a fragmentary condition, in the zone to which its name has been applied, where it occurs associated with *M. limatulus*, *M. involutus*, *M. Clingani*, *M. lobiferus*, *M. leptotheca*, *Rastrites peregrinus*, *Climacog. scalaris*, *Cephalog. cometa*, etc.

Collections.—Geological Survey of England and Wales, and of Scotland, British Museum (Natural History), Sedgwick Museum, Lapworth, and the Authors.

Monograptus decipiens, Törnquist. Plate XLVII, figs. 3 *a*—*e*.

1899. *Monograptus decipiens*, Törnquist, Monog. of Scanian *Rastrites* beds, p. 20, pl. iv, figs. 9—14.

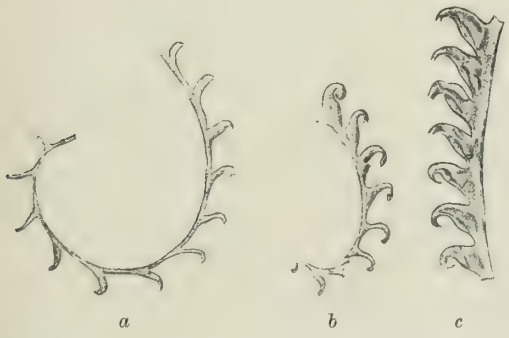
Polypary small, in the form of a rather irregular plane spiral, widening rapidly from an initial breadth of 1 mm. to a maximum diameter of about 2 mm. Thecæ ten to eight in 10 mm., on the convex margin; of two types, those of the proximal portion of the linear isolated *Rastrites* type, those of the distal portion in contact, triangular, free about seven-ninths of their length, with relatively conspicuous apertural barbs, in which about one-third of this free portion is involved.

Description.—The polypary varies somewhat in form, but consists generally of two involutions, and the distal extremity tends to become straight. In its proximal portion it augments very rapidly in width, and the change from the isolate thecæ of the initial region to the broader triangulate thecæ, which increase very rapidly in size throughout the early whorls, is most striking and characteristic.

The sicula is rather short, not reaching the isolate region of th. 1.

The thecæ as a whole change their form gradually, those of the distal portion of the polypary having more conspicuous apertural barbs than is usual in most members of this group.

FIGS. 325 *a*—*c*.—*Monograptus decipiens*, Törnquist.



a. Proximal fragment, showing sicula. E. side Quarry, N.E. of Fagwr-fawr Farm, Pont Erwyd, Cardiganshire. Geol. Survey of England and Wales.

b. Fragment in relief, showing characteristic barbs. On same slab as Pl. XLVII, fig. 3 *c*.

c. Distal thecæ. Enlargement of part of Pl. XLVII, fig. 3 *d*.

Affinities.—*Monog. decipiens* approaches *M. convolutus* in respect of its general shape, but differs in the more rapid augmentation in width in the proximal portion and also in the characters of the distal thecæ, which have far more conspicuous apertural barbs. From *M. involutus*, which it also somewhat resembles, it is distinguished by these same characters and by the presence of *Rastrites*-like thecæ in the initial portion of the polypary.

Horizon and Localities.—Llandovery (zone of *M. convolutus*).

S. Scotland: Belcraig Burn; Dobb's Linn; Clanyard Bay, Port Logan. *Lake District:* Tributary of Hall Gill. *Wales:* River Twymyn, near Llanbrynmair; E. side quarry, N.E. of Fagwr-fawr Farm, Pont Erwyd.

Associates, etc.—*Monog. decipiens* is not a very common fossil, but it occurs sometimes in fair abundance, as, for example, at Belcraig, in the zone of *M. convolutus*, where it is associated with *M. convolutus*, *M. limatulus*, *M. Clingani*, and *M. lobiferus*.

Collections.—Geological Survey of England and Wales, and of Scotland, Sedgwick Museum, and the Authors.

Monograptus urceolus, Richter. Plate XLVIII, figs. 1 *a*—*d*.

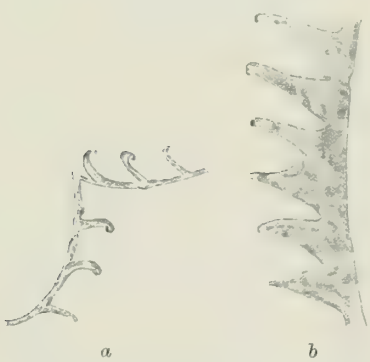
1853. *Monograptus urceolus*, Richter, Thüringische Graptolithen, Zeitschr. d. deutsch. geol. Gesell., vol. v, p. 462, pl. 12, figs. 29, 30.

1899. *Rastrites urceolus*, Eisel, Die Zonenfolge d. ostthüring. u. vogtländ. Graptolithenschiefer, p. 6.

1907. *Monograptus* cfr. *urceolus*, Törnquist, *Rastrites* and allied species of *Monograptus*, Lund. Univ. Årsskr., N.S., afd. 2, iii, no. 5, p. 18, pl. iii, figs. 5–10.

1911. *Demirastrites urceolus*, Eisel, Ueber zonenweise Entwick. d. *Rastriten* u. *Demirastriten* i. d. mittelsil. Graptolithenschiefern Thüringens u. Sachsens, p. 15, pl. ii, figs. 25—32.

Polypary in the form of a loose helicoid spiral, very slender in the proximal portion, but widening rapidly to a maximum breadth of about 2 mm. Thecæ eleven to twelve in 10 mm., of two types; those of the proximal portion linear and isolate like those of *Rastrites*, those of the distal portion in contact, broadly triangular, with fully two-thirds of the thecal length isolate.



Figs. 326 *a* and *b*.—*Monograptus urceolus*, Richter.

a. Proximal fragments, showing character of proximal thecæ. Enlargement of part of Pl. XLVIII, fig. 1 *a*.
b. Distal thecæ. Enlargement of specimen on same slab as Pl. XLVIII, figs. 1 *b* and 1 *c*.

Description.—The loose helicoid spiral starts to grow somewhat in the same way as *M. proteus*, but the whole form is very irregular and difficult to determine from our British specimens.

The sicula is small, rather shorter than the isolate part of th. 1.

The thecæ are usually borne on the convex margin, but this is not invariably the case. There is a comparatively long proximal portion in which the thecæ are of the isolate *Rastrites* type, but those of the remaining portion are bluntly triangular, with a loose barb at the termination, in which the merest fraction of the thecal length is involved.

Affinities.—*Monog. urceolus* resembles *M. proteus* somewhat in its general fashion of growth, but has different proximal thecæ. From *M. decipiens*, which it resembles in the general thecal characteristics, it differs in some details of the thecæ and in its general plan of growth.

Horizon and Localities.—Llandovery (zone of *M. convolutus*).

S. Scotland: Belcraig Burn; Duffkinnel, Wamphray.

Associates, etc.—*Monog. urceolus* is not a very common fossil in a complete state, but it is possible that many fragments which occur in the zone of *M. convolutus* should really be referred to it; it is found with *M. convolutus*, *M. Clingani*, *M. lobiferus*, etc.

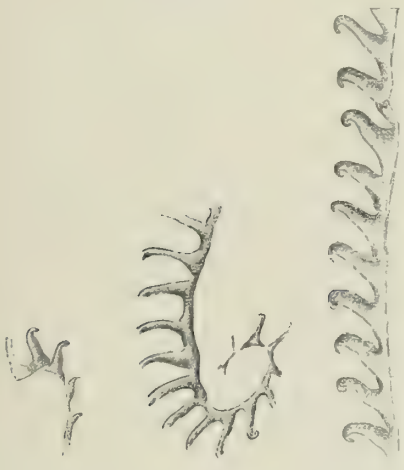
Collections.—Geological Survey of Scotland, and Dr. Dairon, Kelvingrove Museum, Glasgow.

VI. A. (*b*) : *Monograpti* in which the thecæ are bi-form and the polypary has dorsal curvature.

Monograptus triangulatus (Harkness). Plate XLVII, figs. 4 *a—f*.

1851. *Rastrites triangulatus*, Harkness, Quart. Journ. Geol. Soc., vol. vii, p. 59, pl. i, figs. 3 *a—d*.
1876. *Monograptus triangulatus*, Lapworth, Geol. Mag. [2], vol. iii, p. 359, pl. xiii, figs. 5 *a*, *b*.

FIGS. 327 *a—c.*—*Monograptus triangulatus* (Harkness).



a *b* *c*

a. Proximal fragment in relief, showing sicula. 430 yards S.S.E. of Brynchwith Farmhouse, Pont Erwyd, Cardiganshire. Geol. Survey of England and Wales.
b. Proximal fragment in full relief. Enlargement of part of Pl. XLVII, fig. 4 *a*.
c. Distal thecæ preserved as a cast, showing barbed apertural terminations. Same locality as fig. 327 *a*.

Polypary variable in length, but usually small, circinate, with sharply recurved proximal portion, widening at first rapidly, and then more gradually till the maximum breadth of 2 mm. is attained. Thecæ ten to eight in 10 mm., on the convex margin, in contact only, linear-triangulate in form, free four-fifths of length, with small barbed apertural terminations, in which only one-fourth of the thecal length is involved.

Description.—The polypary is commonly about 3—4 cm. in length, but there is one long specimen in the Kelvingrove Museum, Glasgow, that has a length of 10 cm. exclusive of the circinate portion; such specimens must, however, be rare.

The sicula is small, measuring about ·9 mm. in length, reaching nearly to the level of the top of th. 1, which is appressed to it throughout its extent, and then grows away from it for another ·5 mm., terminating in a barbed apertural region.

Th. 2 is similar in form but shorter. Thus far the polypary is extremely slender, but thereafter increases gradually in breath, and the thecæ continue to increase in length until the maximum breadth is attained.

The thecæ are commonly preserved to show merely acutely pointed apices, but here and there one may be detected with the characteristic barbed apertural region, and in specimens preserved in relief the barbs are usually quite clearly seen, though only a small fraction of the thecal length is involved in their formation.

Affinities.—*Monog. triangulatus* is a very well marked species; proximal fragments might perhaps be confused with those of *M. fimbriatus* or *M. communis*, but the linear-triangulate distal thecæ should render the identification of mature specimens comparatively easy.

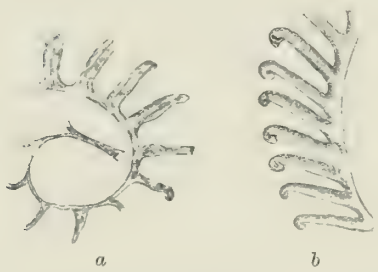
Horizon and Localities.—Llandovery (zone of *M. gregarius*).

S. Scotland: Dobb's Linn; Belcraig Burn; Frenchland Burn; Lockerbie, etc. *Lake District:* Skelgill; Spengill Head, etc. *Ireland:* Coalpit Bay, Donaghadee; Little River, Pomeroy; Side Valley, Mullaghnabuoyah, Pomeroy. *Wales*: Mona Mine, Parys Mountain; Rheidol Gorge, 430 yds. S.S.E. Bryn-chwîth Farm, Pont Erwyd, etc.

Associates, etc.—*Monog. triangulatus* is one of the very commonest fossils in the *M. gregarius* zone; it usually makes its appearance at the base associated with *M. gregarius*, *M. fimbriatus*, *Rastrites approximatus*, *Mesog. magnus*, *Climacog. Törnquisti*, etc., and continues up to the very summit of the zone.

Collections.—British Museum (Natural History), Sedgwick Museum, Geological Survey of England and Wales, and of Scotland, Kelvingrove Museum, Glasgow, Lapworth, Jones, and the Authors.

Var. **major**, var. nov. Plate XLVII, figs. 5 *a—d*.



Figs. 328 *a* and *b*.—*Monograptus triangulatus*, var. *major*, nov.

a. Proximal fragment, showing sicula. Donaghadee, Ireland. Belfast Natural History Museum.

b. Distal fragment preserved as a cast. Same locality as Pl. XLVII, fig. 5 *c*.

At the top of the zone of *M. gregarius* there commonly appears a variety of *M. triangulatus*, in which the curvature is, as a rule, broader, and the thecæ much longer than in the typical form, approximately seven-eighths of the total length being isolate, though the relative fraction involved in the barb remains the same. This increase in length of the thecæ makes the whole polypary of greater breadth, and the appearance of the polypary is altogether more robust, while the thecæ are somewhat closer set, numbering twelve to seven in 10 mm., and having a length of 2·5 to 3 mm. The sicula also is longer, measuring 1·5 mm. in length.

Horizon and Localities.—Llandovery (zone of *M. gregarius*, especially upper part).

S. Scotland: Dobb's Linn; Belcraig Burn. *Lake District:* Skelgill. *Wales:* Llanystwmdwy; Rheidol Gorge, 430 yds. S.S.E. of Bryn-chwîth Farm, Pont Erwyd.

Associates, etc.—Var. *major* occurs in the zone of *M. gregarius*, associated with the zone fossil, *M. communis*, *Glyptog. tamariscus*, *Climacog. Törnquisti*, and *Petalog. palmeus* var. *latus*.

Collections.—Geological Survey of England and Wales, British Museum (Natural History), Sedgwick Museum, Jones, Elles.

Monograptus raitzhainiensis (Eisel). Plate XLVIII, figs. 3 *a*—*c*.

1899. *Monograptus triangulatus* var. *Raitzhainiensis*, Eisel, Ueber die Zonenfolge ostthüring. u. vogtländ Graptolithenschiefer, p. 7.

1907. *Monograptus triangulatus* var. *Raitzhainiensis*, Törnquist, *Rastrites* and allied species of *Monograptus*, Lund. Univ. Årsskr., N.S., afd. 2, iii, no. 5, p. 17, pl. iii, figs. 2—4.

Polypary arcuate, with broadly circinate proximal portion, widening from a very slender initial extremity to a maximum breadth of about 1·5 mm. Thecæ on the convex margin, twelve to nine in 10 mm.; of two types, those of the proximal portion of the general isolate *Rastrites* type, those of the distal part in contact, apparently of the *fimbriatus-triangulatus-communis* type, subtriangular, free fully four-fifths of length, with barb-like apertural terminations, in which only one-fifth to one-third of the thecal length is involved.

Description.—The appearance of the polypary is very striking, the difference in the proximal and distal thecæ being most obvious.

The first theca is appressed to the sicula (which has a length of 1 mm.) for the greater part of its length, but the succeeding ones are linear and isolate, this feature being characteristic of at least eight thecæ; then the adnate region becomes broader and stouter like that of *M. triangulatus*, and finally the whole theca broadens and resembles that of *M. fimbriatus*. The lower wall, however, still retains traces of concave curvature, and the thecæ are really less blunt and more widely separated from each other than in the true *M. fimbriatus*, approaching *M. communis* in this respect, but having longer thecæ with less pronounced reflexion of the apertural region.

FIGS. 329 *a* and *b*.—*Monograptus raitzhainiensis* (Eisel).

a *b*

a. Proximal portion. Enlargement of part of Pl. XLVIII, fig. 3 *a*.
b. Distal thecæ. Enlargement of part of Pl. XLVIII, fig. 3 *c*.

Affinities.—*Monog. raitzhainiensis* is in its way unique, and if carefully examined can readily be distinguished from any of the above-mentioned forms to which it bears a certain amount of resemblance.

Horizon and Localities.—Llandovery (zone of *M. gregarius*, near base).

S. Scotland: Long Linn, Dobb's Linn. *Wales:* Rheidol Gorge, 430 yds S.S.E. Bryn-chwîth Farm, Pont Erwyd. *Lake District:* Skelgill ?

Associates, etc.—*Monog. raitzhainiensis* seems to be one of the earliest of all the members of this group; it makes its appearance at the very base of the zone of *M. gregarius* immediately above the zone of *M. cyphus;* here it occurs in association with *M. fimbriatus*, *M. revolutus*, *M. Sandersoni*, *M. gregarius*, *Climacog. Törnquisti*, *Rastrites approximatus*, *Petalog. palmeus* var. *latus*, etc. Jones has also found it, at a slightly higher horizon, in his *M. communis* zone (*Mesog. magnus* band) with *M. communis*, *M. gregarius*, *Mesog. magnus*, *Climacog. Törnquisti*, and *Rastrites approximatus*.

Collections.—Jones, Geological Survey of England and Wales, Sedgwick Museum, Elles.

Monograptus denticulatus, Törnquist. Plate XLVIII, figs. 2 *a—f*.

1899. *Monograptus denticulatus*, Törnquist, Monog. of Scanian *Rastrites* beds, p. 18, pl. iii, figs. 19—23.

Polypary small, not exceeding 4 cm. in length, and commonly even smaller, arcuate, with broadly recurved proximal portion widening quickly from an initial breadth of about ·7 mm. to a maximum diameter of 1·3 mm. Thecæ on the convex margin, eight to nine in 10 mm.; those of the proximal portion of the *M. triangulatus* type, those of the distal portion of the general *M. communis* type.

Description.—The polypary is usually small, but longer specimens are occasionally met with, all showing considerable variation in the amount of circination of the proximal end.

Fig. 330.—*Monograptus denticulatus*, Törnquist.

Proximal portion. Enlargement of part of Pl. XLVIII, fig. 2 *b*.

The sicula has a length of about 1 mm. and forms the proximal termination of the polypary, th. 1 arising some distance above its base.

The two distinct types of thecæ are highly characteristic and very conspicuous, those of the proximal portion being linear-triangulate in form, while those of the distal portion widen out till they come to resemble those of *M. communis*, though with a rather less conspicuously reflexed apertural region. As Törnquist has already noted, the combined effect of compression and slight torsion of the thecal axis results in curious views being presented. One of the most misleading

is the one in which the barbed apertural region is entirely concealed and the thecæ present a superficial resemblance to those of *M. fimbriatus*.

Affinities.—Distal fragments of *Monog. denticulatus* may resemble those of *M. communis* or *M. fimbriatus*, but can be distinguished, as the thecæ of *M. communis* are really more conspicuously lobed in their apertural regions, and those of *M. fimbriatus* far more closely set. If the whole polypary is seen, it is easily separable from those of other species, the two types of thecæ rendering it sufficiently distinct.

Horizon and Localities.—Llandovery (zone of *M. convolutus*.)

S. Scotland: Corrie, Dobb's Linn; Long Linn, Dobb's Linn; Belcraig Burn. *Lake District:* Skelgill.

Associates, etc.—*Monog. denticulatus* is a very common fossil in S. Scotland in the zone of *M. convolutus*, where it occurs in swarms associated with *M. limatulus*, *M. Clingani*, *M. lobiferus*, *Petalog. folium*, etc.

Collections.—Geological Survey of Scotland, British Museum (Natural History), Lapworth, and the authors.

VI. B. (*a*): *Monograpti* in which the thecæ are uniform and the polypary has spiral curvature.

Monograptus spiralis (Geinitz). Plate XLVIII, figs. 7 *a—d*.

1842. *Graptolithus spiralis*, Geinitz, Neues Jahrb. f. Min., p. 700, pl. x.
1850. *Graptolithus spiralis*, Barrande, Grapt. de Bohême, p. 54, pl. iii, figs. 10—13.
1892. *Monograptus spiralis β. subconicus*, Törnquist, Siljansområdets Grapt., ii, p. 35, pl. iii, figs. 12—23.

Polypary robust, coiled into an irregular spiral, widening from a slender proximal portion persistently throughout its extent. Thecæ on the convex margin, eight to nine in 10 mm., of uniform type; sub-triangular with slight torsion, in contact only, free one-fourth to one-fifth of length and with barbed apertural region in which one-half of the free part is involved.

FIG. 331 *a*.—*Monograptus spiralis* (Geinitz).

a

a. Proximal portion, preserved as a cast. Thirlstane Score, S. Scotland; band of *Rastrites maximus*. Coll. Lapworth.

Description.—The polypary varies considerably in appearance according to preservation; sometimes it is coiled into a perfectly regular plane spiral (Pl. XLVIII, fig. 7 *d*), at others the spiral is most irregular and the convolutions far from symmetrical (Pl. XLVIII, fig. 7 *b*). Distal fragments which are

almost straight are of fairly frequent occurrence, and seem to imply that at its distal extremity the polypary was not convolute but merely somewhat arcuate, as is the case also in *M. convolutus*.

The thecæ, too, which differ slightly in the proximal and distal portions of the polypary, have a still further degree of variation impressed upon them by the conditions of preservation. The early thecæ are all small, in contact only, and with very definite reflexion of the apertural region. This character is maintained in those of the first few whorls of the polypary, and since the thecæ steadily become larger and larger, the polypary increases correspondingly in breadth; but nevertheless the amount of the whole theca involved in the reflexed barb does not increase, in fact the amount of reflexion *decreases* much in the same manner as in *M. convolutus*. These are the original characters of the thecæ, but as the result of the mode of preservation, it not infrequently happens that the thecæ of the earlier portion of the polypary have their reflexed apertural regions twisted away from the observer and embedded in the rock matrix, and hence appear merely subtriangular in form, and this may persist throughout the whole extent of the polpary; in these cases there is, however, other evidence that the appearance presented is not that of a mid-profile view.

FIGS. 331 *b* and *c*.—*Monograptus spiralis* (Geinitz).

b. Distal thecæ. Enlargement of part of specimen on same slab as Pl. XLVIII, fig. 7 *c*.
c. Distal thecæ, showing different appearances presented after compression. Ibid.

Affinities.—*Monog. spiralis* presents many points of resemblance to *M. convolutus*, but may be easily separated by the more persistent widening and greater robustness of the polypary. From *M. circularis* it differs in the form of the distal thecæ. From other species its form is sufficient to distinguish it.

Horizon and Localities.—Tarannon Beds (throughout).

S. Scotland: Belcraig Burn; River Gala, N.W. Buckholm Mill; Thirlstane Score, etc. *Wales:* Tarannon River; Road 300 yds. W. of Llawr-y-coed; Plasbach Stream, Llanbrynmair; Afon Cwm Calch, Llanbrynmair, etc.; Nant Fucheswen, Pont Erwyd. *Ireland:* Tieveshilly; Portaferry, Co. Down. *Lake District:* Pull Beck; Swindale; Rawthey Bridge, Sedbergh.

Associates, etc.—*Monog. spiralis* is a fairly abundant graptolite throughout the rocks of Gala-Tarannon age; the smaller individuals are usually found in the lower beds, but those from the *M. griestoniensis* zone are often of considerable size. Its associates are the entire Tarannon fauna.

Collections.—Geological Survey of Scotland, Sedgwick Museum, Jones, Swanston, Lapworth, and the Authors.

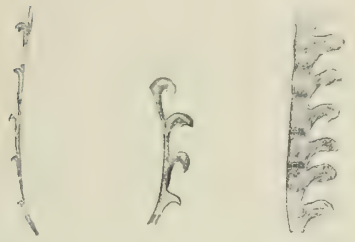
Monograptus proteus (Barrande). Plate XLVIII, figs. 8 *a*—*c*.

1850. *Graptolithus proteus*, Barrande, Grapt. de Bohême, p. 58, pl. iv, figs. 12—14.
1890. *Monograptus proteus*, Geinitz, Grapt. Dresden Museum, p. 21, pl. A, fig. 28.
1892. *Monograptus proteus*, Törnquist, Siljansområd. Grapt., ii, p. 40, pl. iii, figs. 29, 30.
1897. *Monograptus proteus*, Perner, Grapt. de Bohême, p. 14, pl. 22, figs. 21—23.
1899. *Monograptus proteus*, Törnquist, Monograptidæ of Scanian *Rastrites* beds, p. 23, pl. iv, figs. 23—24.

Polypary coiled into a helicoid spiral, with long and extremely slender proximal portion and fairly robust distal portion. Thecæ seven to ten in 10 mm., of uniform type, triangular, in contact only, with barbed apertural regions, in which only one-third of the free part is involved; those of the proximal portion of the polypary more distant and more slender than those of the distal portion.

Description.—The polypary rarely shows the whole of the slender proximal end, but when this is complete it is seen to widen very gradually at first and then somewhat more rapidly, for in its distal portions the polypary is fairly robust; fragments of this part are of far commoner occurrence than those of the initial extremity.

FIGS. 332 *a*—*c*.—*Monograptus proteus* (Barrande).



a

b

c

a. Proximal portion, showing form of thecæ. Gelli-dywyll Stream, Llanbrynmair; Brynmair Beds. Coll. Wood.

b. Slightly more distal thecæ, in low relief, showing form of apertural margins. Enlargement of part of Pl. XLVIII, fig. 8 *c*.

c. Distal thecæ of same specimen, in low relief.

In the most characteristic form of the polypary the thecæ are all on the outer side of the curve, and therefore symmetrically arranged, but this is not a constant feature. The proximal thecæ are all extremely slender, with distinct though small barbed apertural regions. The gradual change in the form of the thecæ towards the distal end can best be seen by comparing figs. 332 *a*—*c*.

Affinities.—The helicoid (conical) spiral of *Monog. proteus*, combined with the arrangement and form of the thecæ, renders the species easy to separate from all others.

Horizon and Localities.—Llandovery-Tarannon Beds (zone of *M. convolutus*, to zone of *M. crispus*).

S. Scotland: Dobb's Linn; Belcraig; Duffkinnell; Mount Benger; Grieston; Broad Meadows, etc. *Wales:* Bont Dolgadfan, Llanbrynmair; Gelli-dywyll Stream, Llanbrynmair, etc. *Lake District:* Browgill. *Ireland:* Portaferry, Co. Down.

Associates, etc.—*Monog. proteus* is not uncommon in the beds of the Upper Birkhill Shales and Lower Gala and their equivalents. It occurs in the zone of *M. convolutus*, associated with *M. convolutus*, *M. Clingani*, *M. limatulus*, *M. lobiferus*,

Climacog. scalaris, etc.; in the zone of *M. Sedgwickii* with *M. tenuis*, *Climacog. scalaris*, and the zone fossil; in the zone of *M. turriculatus* with *M. turriculatus*, *M. Halli*, *Rastrites maximus*, *M. dextrorsus*, and *Petalog. altissimus*; and in the zone of *M. crispus* with *M. crispus*, *M. exiguus*, *M. Marri*, and *M. discus*.

Collections.—Geological Survey of Scotland, Sedgwick Museum, Belfast Natural History Museum, Lapworth, and the Authors.

Monograptus delicatulus, sp. nov. Plate XLVII, figs. 2 *a* and *b*.

Polypary slender, coiled into an irregular spiral, increasing gradually in width until the maximum diameter of about 1 mm. is attained. Thecæ ten in 10 mm., of the general type of those of the mature portion of *M. convolutus*, but altogether smaller.

Description.—The curvature of the polypary is usually irregular, the whorls rarely lying in one plane, and even then being unsymmetrically disposed; in some specimens the curvature recalls that characteristic of *M. involutus*.

FIG. 333.—*Monograptus delicatulus*, sp. nov.

Specimen showing character of proximal thecæ. Enlargement of part of Pl. XLVII, fig. 2 *b*.

The thecæ, while resembling those of *M. convolutus*, are of uniform type throughout, being never completely isolate and linear; the thecæ of the proximal portion, however, are decidedly more distant than those of the more distal part of the polypary.

Affinities. — Superficially *Monog. delicatulus* resembles *M. convolutus*, but the absence of *Rastrites*-like thecæ in the proximal portion, and the greater tenuity of the polypary as a whole, make its identification fairly easy. From *M. involutus*, which it sometimes approaches in general form, it differs in the more spinose character of the thecal terminations.

Horizon and Localities.—Llandovery Beds (zones of *M. gregarius* and *M. convolutus*).

S. Scotland: The Corrie, Dobb's Linn; Sundhope-on-Yarrow, etc.

Associates, etc.—*Monog. delicatulus* is a comparatively rare fossil in the zones of *M. gregarius* and *M. convolutus*. In the latter it occurs associated with *M. convolutus*, *M. jaculum*, and *Cephalog. cometa*.

Collections.—Lapworth and the Authors.

Monograptus involutus (Lapworth). Plate XLIX, figs. 4 *a*—*c*.

1876. *Monograptus intermedius* var. *involutus*, Lapworth, Geol. Mag. [2], vol. iii, p. 316, pl. x, fig. 11.

Polypary an involute plane spiral of somewhat irregular form, with slender thread-like proximal portion, and widening fairly rapidly to a maximum diameter of rather less than 1 mm. Thecæ on the outer side of the curve, eight in 10 mm., of the type characteristic of *M. communis*, but somewhat smaller.

Description.—The irregular involutions of the polypary are highly distinctive of the species, though the amount of curvature varies very much in different individuals.

FIGS. 334 *a*—*c*.—*Monograptus involutus* (Lapworth).

a. Proximal thecæ. Enlargement of part of Pl. XLIX, fig. 4 *a*.
b and *c*. Different appearances of the thecæ. Sundhope-on-Yarrow; Birkhill Shales. Coll. Lapworth.

The proximal portion is very slender and the thecæ minute, so that it is difficult to make out the details. The distal thecæ present many different appearances under compression, but are generally of the type of those of *M. communis*.

Affinities.—As regards the form of the polypary *Monog. involutus* approaches *M. delicatulus*, but is still more irregularly curved. The thecæ agree very closely with those of *M. communis*, but in that species the curvature of the polypary is quite different.

Horizon and Localities.—Llandovery (zones of *M. convolutus* and *M. Sedgwickii*).

S. Scotland: Dobb's Linn; Garple Linn; Frenchland Burn; Belcraig Burn; Head of Pishnack Burn, Wee Queensbury; Sundhope-on-Yarrow; Glenkiln Burn. *Wales:* W. side Old Quarry, N.E. of Fagwr-fawr, Pont Erwyd. *Ireland:* Near Limehill, Co. Tyrone. *Lake District:* Skelgill.

Associates, etc.—*Monog. involutus* is a fairly common fossil, and is found most abundantly in the zone of *M. convolutus* associated with *M. leptotheca*, *M. lobiferus*, *M. convolutus* and *M. Clingani*; it is also found, but more rarely, at the higher horizon with *M. tenuis* and *M. Sedgwickii*.

Collections.—Geological Survey of England and Wales, Sedgwick Museum, Lapworth, and the Authors.

Monograptus circularis, sp. nov. Plate XLVIII, figs. 9 *a* and *b*.

Polypary slender, convolute, coiled into a plane spiral fairly regular in shape, of a uniform breadth of about 1 mm. Thecæ eight in 10 mm., of the type of those of *M. communis*.

Description.—The polypary is coiled in much the same way as the more regular forms of *M. spiralis*, but the curvature varies somewhat in different specimens.

Fig. 335.—*Monograptus circularis*, sp. nov.

Enlargement of part of Pl. XLVIII, fig. 9 *a*.

The thecæ, although somewhat smaller, resemble in all other particulars those of *M. communis*, and there is no sign of the rapid increase in size of the distal thecæ so characteristic of *M. spiralis*.

Affinities.—*Monog. circularis* agrees with *M. convolutus* and *M. spiralis* in general form, but may readily be distinguished from these by the different characters of the thecæ. From *M. communis*, with which it agrees in the shape of the thecæ, it differs completely in the form of the polypary.

Horizon and Localities.—Llandovery (zone of *M. Sedgwickii*).

S. Scotland: Plewlands Burn, Raehills (Duffkinnell); the Corrie, Dobb's Linn.

Associates, etc.—*Monog. circularis* is a rather rare fossil in the Upper Birkhill Shales, where it occurs with *M. Sedgwickii* and *M. jaculum*.

Collections.—Geological Survey of Scotland, and Elles.

VI. B. (*b*): *Monograpti* in which the thecæ are uniform and the polypary has dorsal curvature.

Monograptus communis (Lapworth). Plate XLIX, figs. 1 *a*—*e*.

1876. *Monograptus convolutus* var. *communis*, Lapworth, Geol. Mag. [2], vol. iii, p. 358, pl. xiii, figs. 4 *a*, *b*.

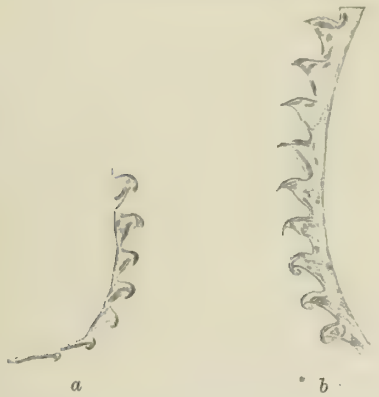
Polypary 5–8 cm. or more in length, arcuate or straight distally, with sharply recurved proximal portion, widening rapidly to a maximum breadth of 1·4 mm., which is uniformly maintained throughout the distal portion. Thecæ eight in 10 mm., on the convex margin, in contact only, short, broadly triangular, free seven-twelfths of length, with reflexed almost lobate apertural regions in which one-third of the total thecal length is involved.

Description.—The curvature of the polypary varies considerably in different individuals. Sometimes it is arcuate throughout, sometimes with broadly, sometimes with narrowly, recurved proximal portion, while the distal portion may be nearly straight.

The sicula has a length of 1·2 mm. and the early thecæ are apparently very small, but this appearance is due to the fact that they are elongated and narrow, with less conspicuous apertural regions; th. 1 seems to have a length of fully 1·5 mm.

The reflexed apertural regions of the thecæ are not always well shown, partly as the result of slight torsion of the thecal axes, and partly as the result of com-

Figs. 336 *a* and *b*.—*Monograptus communis* (Lapworth).



a. Proximal fragment, in relief, probably belonging to this species. 430 yds. S.S.E. of Bryn-chwith Farmhouse, Pont Erwyd, Cardiganshire. Geol. Survey of England and Wales.

b. Distal thecæ, showing different appearances presented after compression. Ladhope Burn, Galashiels; Birkhill Shales. Geol. Survey of Scotland.

pression and method of preservation; even when seen their appearance is very variable, but usually some thecæ show the characteristic form even when very much compressed, and in specimens preserved in relief their true shape is usually seen very beautifully.

Affinities.—It is clear that in *Monog. communis* we have a form in which the thecæ are in many respects intermediate in character between those considered as typical of the group of *M. lobiferus* and those typical of the group of *M. convolutus*; especially is this the case as regards the apertural region, which strongly recalls the lobate form of many members of the group of *M. lobiferus*. Nevertheless the general triangular shape of its thecæ and their greater degree of isolation seem on the whole to link it even more closely with the members of the group of *M. convolutus*, among which it is here consequently included.

Monog. communis might be confused as regards its distal portion with the similar portion of *M. Clingani*, but may be distinguished by the more overlapping thecæ and the more *hooked* apertural regions of the latter species. From *M. millepeda*, to which it bears a close resemblance in the form of the polypary, it may be separated by the less definitely lobate nature of the apertural regions.

Horizon and Localities.—Llandovery (zones of *M. gregarius* and *M. convolutus*). *S. Scotland:* Dobb's Linn; Belcraig Burn; Garple Linn; Frenchland Burn; Lockerbie, etc. *Wales:* Rheidol Gorge, 430 yds. S.S.E. Bryn-chwîth Farm, Pont Erwyd, etc. *Lake District:* Skelgill. *Ireland:* Little River, Pomeroy.

Associates, etc.—*Monog. communis* is a common fossil in the lower part of the Upper Birkhill Shales of S. Scotland and their equivalents elsewhere; it occurs in association with *M. gregarius*, *M. triangulatus*, and var. *major*, *M. Clingani*, *M. convolutus*, *Petalog. folium*, *P. palmeus*, *Cephalog. cometa*, etc. It is also fairly common in Ireland and in the Lake District.

Collections.—Geological Survey of England and Wales, and of Scotland, Sedgwick Museum, British Museum (Natural History), Jones, Lapworth, and the Authors.

Var. **rostratus**, var. nov. Plate XLIX, figs. 2 *a*—*c*.

This variety of *Monog. communis* is very similar to the common form as regards the shape of the polypary, but the thecæ are much longer and more rostrate,

Fig. 337.—*Monograptus communis*, var. *rostratus*, nov.

Proximal thecæ. Enlargement of part of Pl. XLIX, fig. 2 *b*.

especially in the proximal region, measuring fully 1·8 mm., and hence the polypary is decidedly broader.

Horizon and Localities.—Llandovery (zones of *M. gregarius* and *M. convolutus*.)

S. Scotland: Dobb's Linn. *Wales:* Rheidol Gorge, 430 yds. S.S.E. Bryn-chwîth Farm, Pont Erywd.

Collections.—Geological Survey of England and Wales, and of Scotland, Sedgwick Museum, Lapworth.

Monograptus fimbriatus (Nicholson). Plate XLVIII, figs. 4 *a—d*.

1868. *Graptolites fimbriatus*, Nicholson, Quart. Journ. Geol. Soc., vol. xxiv, p. 536, pl. xx, figs. 3—5.

Polypary small but relatively broad, arcuate, with circinate proximal portion, widening quickly to a maximum breadth of 1·8 mm. Thecæ on the convex margin, twelve to nine in 10 mm., those of the proximal portion somewhat more slender than those of the more distal portion, which also have blunter reflexed apertural terminations in which the merest fraction of the thecal length is involved.

Description.—The polypary does not usually exceed 4 cm. in length, and smaller forms are of far commoner occurrence; the circination of the proximal portion is always pronounced.

Figs. 338 *a* and *b*.—*Monograptus fimbriatus* (Nicholson).

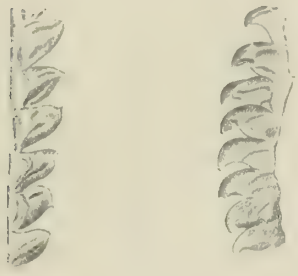
a

a. Proximal fragment, preserved as a cast, showing sicula. Skelgill, Lake District. Coll. Lapworth (presented by H. A. Nicholson).
. Proximal fragment in relief. Skelgill, Lake District; Skelgill Beds. Coll. Lapworth.

The sicula is small, barely reaching 1 mm. in length.

The thecæ of the initial portion are rather different from those developed later, they are distant, relatively long, slender, and triangular in form, with sharply reflexed apertural regions; they change gradually in shape, however, becoming closer set, shorter and broader, with more bluntly reflexed apertural regions. This latter type is the characteristic *fimbriatus* type, while the earlier thecæ appear to approach those of *M. triangulatus*. It is not clear, however, whether the difference in the form of the proximal and distal thecæ is not merely an *appearance* due to torsion. Should

Figs. 338 *c* and *d*.—*Monograptus fimbriatus* (Nicholson).



c

d

c. Distal fragment, in relief, preserved so that apertural margins are concealed. Same locality as fig. 338 *b*.
d. Distal thecæ showing reflexed apertural terminations. Ibid.

it eventually be proved to be a character of specific value, the form next described as a variety would have to be regarded as a separate species.

Affinities.—As respects the character of the proximal end, *Monog. fimbriatus* approaches *M. triangulatus*, but differs from it in the characters of the distal thecæ. It also resembles var. *similis* in the form of the polypary and the characters of the distal thecæ, but differs in those of the proximal portion of the polypary.

Horizon and Localities.—Llandovery (base of zone of *M. gregarius*, sub-zone of *M. fimbriatus*).

S. Scotland: Dobb's Linn; Frenchland Burn; Garple Linn. *Lake District:* Skelgill. *Ireland:* Coalpit Bay, Donaghadee. *Wales:* Rheidol Gorge, 420 and 430 yds. S.S.E. of Bryn-chwîth Farm, Pont Erwyd; Llanystwmdwy.

Associates, etc.—*Monog. fimbriatus* is one of the earliest of the *Monograpti*; it occurs in S. Scotland immediately above the zone of *M. cyphus*, associated with *M. gregarius*, *M. revolutus*, *M. raitzhainiensis*, *Glyptog. tamariscus*, *Climacog. Törnquisti*, *Petalog. palmeus* var. *latus*, *P. minor*, etc.

Collections.—British Museum (Natural History), Sedgwick Museum, Jones, Lapworth, and the Authors, etc.

Var. **similis**, var. nov. Plate XLVIII, figs. 5 *a*—*d*.

1876. *Monograptus convolutus* var. *fimbriatus*, Lapworth, Geol. Mag. [2], vol. iii, p. 358, pl. xiii. figs. 4 *c*, *d*.

In addition to the form just described, which appears to be the one designated originally as *Monog. fimbriatus* by Nicholson, there is another closely allied to it which is commoner, especially in beds of the same age in S. Scotland, and which seems to deserve distinction as a variety.

Fig. 339.—*Monograptus fimbriatus* var. *similis*, nov.

Proximal portion, showing sicula. Dobb's Linn; Birkhill Shales. Sedgwick Museum.

In this var. *similis* the circinate portion of the polypary is, as a rule, shorter than in the typical form. The broader type of theca is developed at once, and maintained throughout, while the thecæ themselves are more closely set, numbering eighteen to fourteen in 10 mm. The sicula also is somewhat shorter than in *M. fimbriatus* itself, measuring only ·7 mm. in length.

Horizon and Localities.—Llandovery (base of zone of *M. gregarius*).

S. Scotland: Dobb's Linn; Frenchland Burn; etc. *Lake District:* Skelgill. *Ireland:* Donaghadee.

Associates, etc.—Var. *similis* is found on approximately the same horizon as the typical form and with the same associates, but is commoner in Scotland and rarer in the Lake District.

Collections.—Sedgwick Museum, Marr, Lapworth, and the Authors.

Monograptus planus (Barrande). Plate XLVIII, figs. 6 *a—d*.

1850. *Graptolithus proteus* var. *plana*, Barrande, Grapt. de Bohême, p. 58, pl. 4, fig. 15.
1879. *Monograptus resurgens*, Linnarsson, Gotlands Grapt., p. 515, pl. 23, fig. 13—21.

Polypary small, not exceeding 2 cm. in length, arcuate, with recurved proximal portion, widening rapidly from a slender initial part to a maximum breadth of about 1 mm. Thecæ fourteen to twelve in 10 mm., of uniform type, subtriangular, in contact only, with a considerable fraction of the free region involved in an apertural barb.

FIG. 340.—*Monograptus planus* (Barrande).

Thecæ in full relief, preserved in three-quarter face view at the distal end. Enlargement of part of Pl. XLVIII, fig. 6 *a*.

Description.—The rapid widening of the polypary is very characteristic of the species, and the proximal end is never enrolled as in those species which it slightly resembles.

The thecæ, though smaller in the proximal than in the distal portion, are never inconspicuous; the apertural barb is, however, fairly frequently concealed, and the thecæ then present a bluntly triangular appearance.

Affinities.—*Monog. planus* agrees in some respects with *M. decipiens*, and distal fragments of the two species resemble each other somewhat closely, though the thecæ in *M. decipiens* are more distant than those of *M. planus*. Their proximal ends are, however, quite different, that of *M. planus* being merely recurved and not enrolled, while there is no sign of the *Rastrites*-like proximal thecæ so characteristic of *M. decipiens*. *Monog. planus* reminds one of a *M. spiralis* in which the curvature is arcuate rather than spiral.

Horizon and Localities.—Gala-Tarannon beds (throughout).

Lake District: Hebblethwaite Gill. *Scotland:* Allan Water, nearly opposite Avernel Plantation, 3 miles N.W. of Melrose. *Wales:* Tarannon River; Plasbach stream, near Llanbrynmair, etc.

Associates, etc.—*Monog. planus* occurs throughout the Gala-Tarannon beds associated with their characteristic fossils.

Collections.—Geological Survey of Scotland, Sedgwick Museum, and Wood.

Monograptus intermedius (Carruthers). Plate XLIX, figs. 3 *a*—*c*.

1868. *Graptolithus intermedius*, Carruthers, Geol. Mag., vol. v, p. 126, pl. v, fig. 18.
1872. *Graptolithus acutus*, Hopkinson, Geol. Mag., vol. ix, p. 504, pl. xii, fig. 4.
1876. *Monograptus intermedius*, Lapworth, Geol. Mag. [2], vol. iii, p. 316, pl. x, figs. 10 *a*—*c*.

Polypary several cm. in length, arcuate, proximal end with variable curvature, usually stiffly recurved, very slender throughout, but widening gradually and persistently till a maximum diameter of rather less than 1 mm. is attained. Thecæ borne on the convex margin, eight to ten in 10 mm., of uniform type, subtriangular tubes free two-thirds of their length and with apertural region sharply bent over into a small insignificant barb. Overlap increasing distally.

Description.—The polypary is very slender and delicate throughout, often measuring only ·7 mm. or ·8 mm. in breadth; the curvature of the proximal end is variable, being sometimes merely arcuate, at others sharply recurved, with every gradation between the two extremes.

Figs. 341 *a*—*d*.—*Monograptus intermedius* (Carruthers).

a. Proximal portion. Enlargement of part of Pl. XLIX, fig. 3 *a*.
b. Distal thecæ, showing "*acutus*" appearance in some of the thecæ. Ibid.
c and *d*. Various appearances presented by the thecæ. Ibid.

The thecæ are of the same general type throughout, but those of the initial portion are so extremely slender that they would be almost invisible were it not for the barb of the apertural region; the amount of overlap increases somewhat distally but is never anything but very slight. When the polypary is somewhat twisted the apertural barb is not visible and the thecæ then appear to have a somewhat acute denticle; specimens showing this mode of preservation are not at all uncommon, and it would appear that it was upon such forms that Hopkinson founded his species *M. acutus* (fig. 341 *b*).

Affinities.—The slender nature of the polypary and the characters of the thecæ serve to render *Monog. intermedius* readily recognisable. In some respects, perhaps, it approaches *M. communis*, both as regards general form and general thecal characteristics, but it is altogether a more delicate and slender species.

Horizon and Localities.—Llandovery (zones of *M. gregarius*, *M. convolutus*, and *M. Sedgwickii*).

S. Scotland: Dobb's Linn; Belcraig Burn; Garple Linn; Sundhope-on-Yarrow. *Ireland:* Coalpit Bay, Donaghadee. *Wales:* River Twymyn, near Llanbrynmair.

Associates, etc.—Monog. intermedius is a common fossil in the Upper Birkhill Shales and their equivalents. It occurs in the zone of *M. gregarius*, associated with *M. triangulatus*, *M. gregarius*, *Glyptog. tamariscus*, etc.; in the *M. convolutus* zone with *M. convolutus*, *M. lobiferus*, *M. Clingani*, *M. limatulus*, etc.; and in the *M. Sedgwickii* zone with the zone fossil and *M. tenuis*.

Collections.—Belfast Natural History Museum, Sedgwick Museum, Lapworth, and the Authors.

VI. B. (*c*): *Monograpti* in which the thecæ are uniform, and the polypary has dorsi-ventral curvature.

Monograptus *cf.* **elongatus,** Törnquist. Plate XLIX, figs. 5 *a—c*.

1899. *Monograptus elongatus*, Törnquist, Monog. of Scanian *Rastrites* Beds, p. 17, pl. iii, figs. 12—18.

Polypary long, irregularly flexed, though usually more or less arcuate, with a very slender thread-like initial portion, widening almost imperceptibly to a maximum breadth of 1 mm. Thecæ eight or nine in 10 mm., of uniform type throughout, elongated sub-triangular, isolate about one-third of total length, and with one-half of free region involved in the apertural barb.

Fig. 342.—*Monograptus* cf. *elongatus*, Törnquist.

Distal thecæ, in partial relief. Enlargement of part of Pl. XLIX, fig. 5 *a*.

Description.—The polypary is more or less arcuate, but often so slender that it appears to be somewhat irregularly flexed. In Britain it has only been found in a fragmentary condition.

The thecæ, which are usually on the convex margin, but not invariably so in the irregularly flexed individuals, have a long slender adnate region, whose ventral walls show slight concave curvature, and a shorter slender isolate region of which about one-half is involved in the formation of the apertural barb. The appearance of this barb after compression suggests that there may have been some torsion of the thecal axis, but it is possible that with such a slender polypary the appearance is due to the irregular flexure of the whole polypary.

PLATE XLII.

FIGS. Genus **Monograptus.**

1 *a*—*c*.—*Monograptus galaensis*, Lapworth. (Page 415.)

1 *a*. Type specimen, showing sicula, figured Lapworth, Geol. Mag., 1876, pl. xii, fig. 5 *b*. Meigle Quarry, Selkirkshire. Gala Beds. Lapworth's Collection.

1 *b*. Distal fragment, ? figured Lapworth, loc. cit. supra, fig. 5 *a*. Ibid.

1 *c*. Incomplete proximal fragment, poorly preserved. Cliff, Ettrick Water, Ettrickbridge end, S. Scotland. *Rastrites maximus* band. Geological Survey of Scotland, Edinburgh.

2 *a*—*e*.—*Monograptus priodon* (Bronn). (Page 418.)

2 *a*. Typical specimen, preserved mainly in relief. On same slab as one of figured specimens of *M. griestoniensis*. Grieston Quarry, S. Scotland. Gala Beds. Geological Survey of England and Wales. (11800).

2 *b*. Long distal fragment. Grieston Quarry. Gala Beds. Lapworth's Collection.

2 *c*. Smaller but well preserved specimen in low relief. Afon Tyn-y-rhos, Talerddig, near Llanbrynmair. Talerddig Beds. Wood's Collection.

2 *d*. Small but wide specimen, showing proximal end preserved in full relief. Gwern-y-fed Fach, near Builth. Wenlock Shales. Sedgwick Museum.

2 *e*. Wide distal fragment. Pencerrig, near Builth. Wenlock Shales. Sedgwick Museum (collected by Hopkinson).

3 *a*—*d*.—*Monograptus pandus* (Lapworth). (Page 421.)

3 *a*. Proximal portion, probably referable to this species, (?) figured Lapworth, Graptolites of Co. Down, p. 129, pl. vi, fig. 3 *a*. Tieveshilly, Co. Down. Tarannon Beds. Lapworth's Collection.

3 *b*. Typical distal fragment. Rawthey Bridge, Sedbergh. Browgill Beds. Sedgwick Museum.

3 *c*. Similar wide fragment. Ibid.

3 *d*. Somewhat narrower fragment. Ibid.

4 *a*—*d*.—*Monograptus Marri*, Perner. (Page 422.)

4 *a*. Typical specimen, showing sicula. Tarannon River. Gelli Beds (zone of *M. crispus*). Wood's Collection.

4 *b*. Small proximal fragment. Ibid.

4 *c*. Long distal fragment, preserved partly in low relief. Tarannon River. Talerddig Beds (zone of *M. griestoniensis*). Wood's Collection.

4 *d*. Somewhat flexed specimen. Same locality and horizon as fig. 4 *a*.

5 *a*.—*d*.—*Monograptus Flemingii* (Salter). (Page 425.)

5 *a*. Typical specimen, figured Lapworth, Geol. Mag., 1876, pl. xx, fig. 8 *a*. Riccarton Junction, S. Scotland. Riccarton Beds. Lapworth's Collection.

5 *b*. Similar specimen, preserved partly in low relief. Ibid.

5 *c*. Proximal portion, figured Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 403, fig. 14. River Irfon, near Builth. Wenlock Shales. Elles' Collection.

5 *d*. Very long and somewhat flexed specimen. Ibid.

6 *a*—*d*.—*Monograptus Flemingii*, var. *primus*, Elles and Wood, nom. nov. (Page 426.)

6 *a*. Type specimen, figured Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 402, fig. 11. Dulas Brook, near Builth. Wenlock Beds (zone of *Cyrtog. rigidus*). Elles' Collection.

6 *b*. Somewhat wider specimen, figured Elles, loc. cit. supra, fig. 11. Nant Prophwyd, near Builth (zone of *Cyrtog. rigidus*). Elles' Collection.

6 *c*. Long and wide specimen. Nant Prophwyd, near Builth (zone of *Cyrtog. rigidus*). Elles' Collection.

6 *d*. Shorter and narrower specimen. Ibid.

7 *a*—*d*.—*Monograptus Flemingii*, var. *compactus*, Elles and Wood, nom. nov. (Page 427.)

7 *a*. Type specimen, figured Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 403, fig. 13. River Irfon, near Builth. Wenlock Beds (zone of *Cyrtog. Lundgreni*). Elles' Collection.

7 *b*. Slightly longer specimen with more reflexed proximal end, figured Elles, loc. cit. supra, fig. 13. Ackley Lane, Long Mountain. Wenlock Beds (zone of *Cyrtog. Lundgreni*). Elles' Collection.

7 *c*. Small typical specimen. Llwynrhedith Quarry, Long Mountain, Wenlock Beds (zone of *Cyrtog. Lundgreni*). Elles' Collection.

7 *d*. Larger specimen with more reflexed proximal end. Ibid.

8 *a*—*e*.—*Monograptus riccartonensis*, Lapworth. (Page 424.)

8 *a*. Typical distal fragment, preserved as a cast. Penwhapple Glen, S. Scotland. Wenlock Beds. Lapworth's Collection.

8 *b*. Typical proximal fragment, figured Lapworth, Ann. and Mag. Nat. Hist. [5], vol. 5, pl. iv, fig. 8 *c*. Elliotsfield, near Hawick. Riccarton Beds. Lapworth's Collection.

8 *c*. Small proximal fragment, showing sicula, figured Elles, Quart. Journ. Geol. Soc., vol. lvi, pl. xxiv, fig. 5. Walcot Quarry, Chirbury. Wenlock Beds (zone of *Monog. riccartonensis*). Elles' Collection.

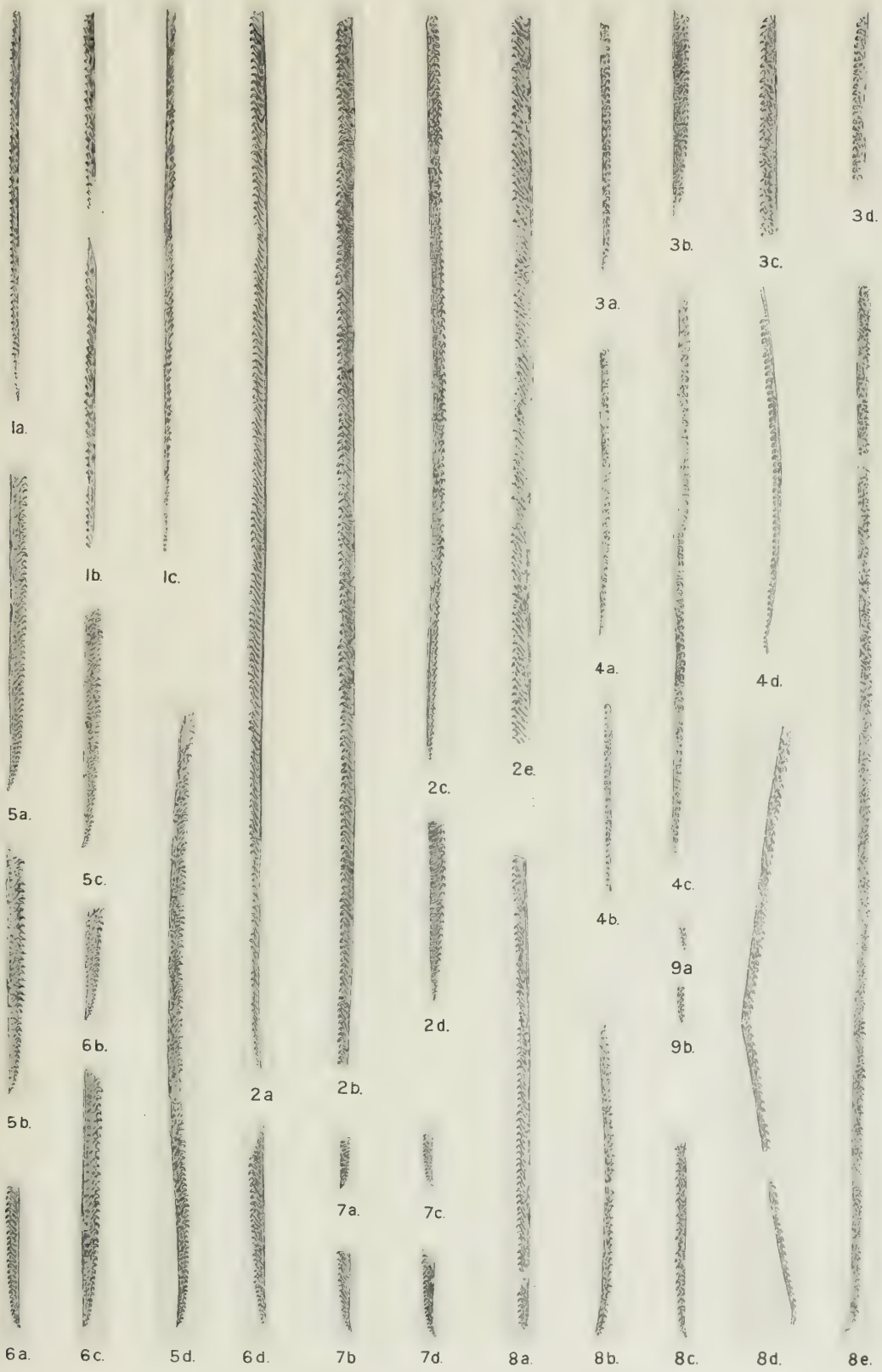
8 *d*. Specimen showing typical "broken-backed" appearance. Llandrindod Wells. Wenlock Beds. Lapworth's Collection.

8 *e*. Very long and stiff specimen. Balmae Shore, near Kirkcudbright. Wenlock Beds. Sedgwick Museum.

9 *a*, *b*.—*Monograptus cultellus*, Törnquist. (Page 423.)

9 *a*. Typical specimen in relief. Road between Llanbrynmair and Talerddig, Montgomeryshire. Nant-ysgollen Shales. Wood's Collection.

9 *b*. Larger fragment, doubtfully referable to this species. Tarannon River. Dolgau Beds. Wood's Collection.



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MONOGRAPTUS.

PLATE XLIII.

Monograptus—*continued.*

FIGS.

1 *a—d.*—*Monograptus uncinatus*, var. *orbatus*, Wood. (Page 427.)

1 *a*. Type specimen, figured Wood, Quart. Journ. Geol. Soc., vol. lvi, pl. xxv, fig. 23 A. Trefnant-Middletown Brook, Long Mountain. Lower Ludlow Shales. Wood's Collection.

1 *b*. Typical specimen, figured Wood, loc. cit. supra, fig. 23 B. Ibid.

1 *c*. Somewhat narrower specimen, partly figured Wood, loc. cit. supra, p. 476, fig. 20 *b*, Wren's Nest, Dudley. Wenlock Shales. Dr. Fraser's Collection.

1 *d*. Broader specimen showing sicula. Trefnant-Middletown Brook, Long Mountain. Lower Ludlow Shales. Sedgwick Museum.

2 *a—c.*—*Monograptus uncinatus*, var. *micropoma* (Jaekel). (Page 428.)

2 *a*. Typical specimen, figured Wood, Quart. Journ. Geol. Soc., vol. lvi, pl. xxv, fig. 24 A. Elton-Ludlow Road. Lower Ludlow Shales. Wood's Collection.

2 *b*. Longer specimen, figured Wood, loc. cit. supra, fig. 24 *B*. Above Garbett's Hall, Long Mountain. Lower Ludlow Shales. Wood's Collection.

2 *c*. Somewhat wider specimen, showing sicula. Stormer Hall, near Leintwardine. Lower Ludlow Shales. Sedgwick Museum.

3.—*Monograptus irfonensis*, Elles. (Page 429.)

Type specimen, figured Elles, Quart. Journ Geol. Soc., vol. lvi, p. 407, fig. 19. River Irfon, near Builth. Wenlock Shales (zone of *Cyrtog. Lundgreni*). Elles' Collection.

4 *a—e.*—*Monograptus flexilis*, Elles. (Page 430.)

4 *a* Type specimen, figured Elles, loc. cit. supra, p. 417, fig. 18. Moel Ferna, Dee Valley. Wenlock Shales (zone of *Cyrtog. Linnarssoni*). Elles' Collection.

4 *b*. Imperfect specimen, on same slab as fig. 4 *a*.

4 *c*. Incomplete but very long specimen, showing flexed form of polypary. Near Gill, Cautley, Yorkshire. Wenlock Beds (zone of *Cyrtog. symmetricus*). Miss Welch's Collection.

4 *d*. Specimen with very long virgella. Middle Gill, Cautley. Wenlock Beds. Welch's Collection.

4 *e*. Similar specimen. Same locality as figs. 4 *a* and *b*.

5 *a—e.*—*Monograptus gemmatus* (Barrande). (Page 436.)

5 *a*. Two specimens, (?) figured Lapworth (as *M. attenuatus*), Geol. Mag., 1876, pl. x, fig. 9 *b*. Dobb's Linn. Upper Birkhill Shales. Lapworth's Collection.

5 *b*. Small curved fragment. Dobb's Linn. Upper Birkhill Shales (band of *Cephalog. cometa*). Wood's Collection.

5 *c*. Broken fragments, preserved in relief. Parys Mountain, Anglesea. Llandovery Beds. G. J. Williams' Collection, Bangor.

5 *d*. Two specimens crossing each other, figured Carruthers (as *M. capillaris*), Geol. Mag., 1868, pl. v, fig. 16. Belcraig Burn, near Moffat. Upper Birkhill Shales. British Museum (Natural History), South Kensington.

5 *e*. Some flexed fragments. Duffkinnell Burn, Wamphray. Birkhill Shales. Geological Survey of Scotland.

6 *a—d.*—*Monograptus distans* (Portlock). (Page 433.)

6 *a*. Typical specimen. Pomeroy, co. Tyrone. Llandovery Beds (zone of *Monog. Sedgwickii*). Geological Survey of England and Wales.

6 *b*. Another specimen, on same slab as fig. 6 *a*.

6 *c*. More distal fragment, on a slab which is the reverse side of that on which figs. 6 *a* and 6 *b* occur. Lapworth's Collection.

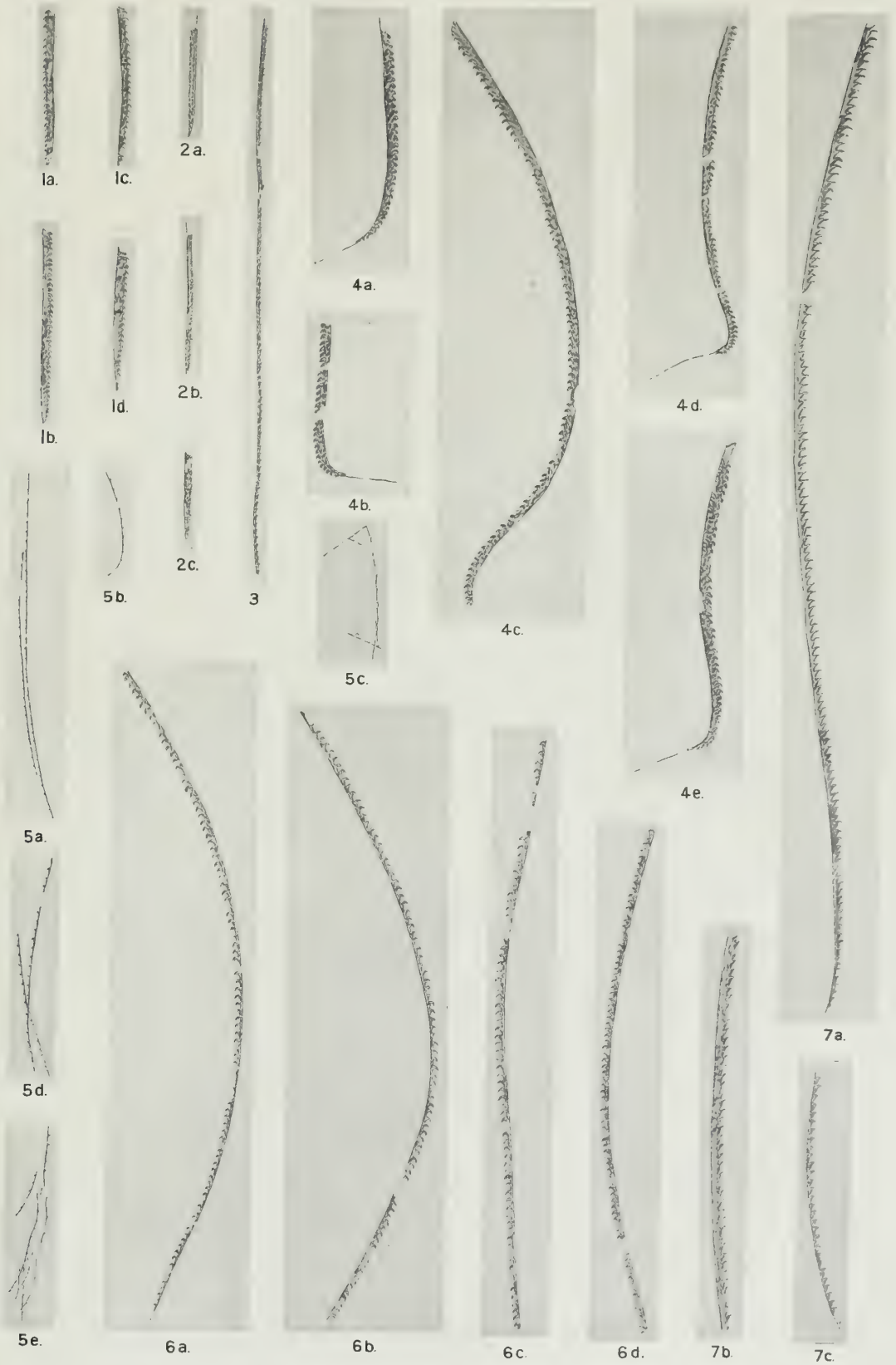
6 *d*. Fragment with more closely set thecæ, but probably referable to this species. The Corrie, Dobb's Linn. Upper Birkhill Shales. Elles' Collection.

7 *a—c.*—*Monograptus acus*, Lapworth MS. (Page 431.)

7 *a*. Large flexed specimen. Grieston-on-Tweed. Gala Beds. Sedgwick Museum.

7 *b*. Distal fragment. Meigle Quarry, S. Scotland. Gala Beds. Lapworth's Collection.

7 *c*. Proximal fragment. Cacra Bank, Tushielaw, Selkirkshire. Gala Beds. Lapworth's Collection.



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MONOGRAPTUS.

PLATE XLIV.

Monograptus—*continued.*

FIGS.

1 *a*, *b*.—*Monograptus Jaekeli*, Perner. (Page 435.)

1 *a*. Distal fragment, with concave curvature. Builth Road, near Builth. Wenlock Shales (zone of *Cyrtog. Linnarssoni*). Elles' Collection.

1 *b*. Distal fragment, with convex curvature. Ibid.

2 *a*—*d*.—*Monograptus scanicus*, Tullberg. (Page 433.)

2 *a*. Specimen showing characteristic curvature, figured Wood, Quart. Journ. Geol. Soc., vol. lvi, pl. xxv, fig. 25 A. Aberedw Hill, near Builth. Lower Ludlow Shales. Wood's Collection.

2 *b*. Distal fragment, figured Wood, loc. cit. supra, fig. 25 B. Ibid.

2 *c*. Small proximal fragment. Elton-Ludlow Road, near Ludlow. Lower Ludlow Shales. Wood's Collection.

2 *d*. Long distal fragment. Lletygynfach, Long Mountain. Lower Ludlow Shales. Lapworth's Collection.

3 *a*—*c*.—*Monograptus crinitus*, Wood. (Page 435.)

3 *a*. Type specimen, figured Wood, loc. cit. supra, pl. xxv, fig. 26 A. Lower Winnington Lane, Long Mountain. Lower Ludlow Shales. Wood's Collection.

3 *b*. Small fragment, figured Wood, loc. cit. supra, p. 481, fig. 23 *c*. On same slab as fig. 3 *a*.

3 *c*. Portion of slab, showing general habit. Lower Winnington Lane. Long Mountain. Lower Ludlow Shales. Wood's Collection.

4 *a*—*e*.—*Monograptus turriculatus* (Barrande). (Page 438.)

4 *a*. Typical specimen. Swindale Beck, Knock, Edenside. Browgill Beds. Sedgwick Museum.

4 *b*. Specimen coiled in less regular spiral. Ibid.

4 *c*. Small typical specimen. Ibid.

4 *d*. Group of small specimens, flattened from above into a plane spiral. Ladhope, Galashiels. Gala Beds. Geological Survey of Scotland.

4 *e*. Large, but imperfect, specimen. Bargany Pond Burn, $2\frac{1}{4}$ miles W. by S. of Dailly, Ayrshire. Gala Beds. Geological Survey of Scotland.

5 *a*—*d*.—*Monograptus discus*, Törnquist. (Page 439.)

5 *a*. Large specimen, with open whorls. Portaferry, Co. Down. Tarannon Beds. Swanston's Collection, Belfast.

5 *b*. Similar specimen. Pen-y-geulan, near Llanbrynmair Station. Gelli Beds. Wood's Collection.

5 *c*. Group of small specimens, preserved as casts. Bryn-yr-odin, near Llangollen. L. J. Wills' Collection.

5 *d*. Small, but typical, specimen. Meigle Quarry, Galashiels. Gala Beds. Lapworth's Collection.

6.—*Monograptus tortilis*, Linnarsson. (Page 440.)

Distal fragment. Sedbergh, Yorkshire. Browgill Beds. Sedgwick Museum.

FIGS.

7 *a*, *b*.—*Monograptus testis*, var. *inornatus*, Elles. (Page 446.)

7 *a*. Type specimen, figured Elles, Quart. Journ. Geol. Soc., vol. lvi, p. 408, fig. 20 *a*. Garbett's Hall, Middletown Brook, Long Mountain. Wenlock Beds. Watts' Collection.

7 *b*. Co-type, figured Elles, loc. cit. supra, fig. 20 *b*. Trewern Brook, near Middletown, Long Mountain. Elles' Collection.

8 *a*—*f*.—*Monograptus Halli* (Barrande). (Page 443.)

8 *a*. Proximal end, presented in a sub-ventral view. Thirlstane Score, near Moffat. Birkhill Shales (band of *Rastrites maximus*). Lapworth's Collection.

8 *b*. Typical distal fragment, showing apertural spines. Belcraig Burn, near Moffat. Band of *R. maximus*. Lapworth's Collection.

8 *c*. Distal fragment in relief, apertural spines turned away and thus concealed from view. Thirlstane Score. Band of *R. maximus*. Lapworth's Collection.

8 *d*. Fragment in relief, apertural margins partly embedded. Ibid.

8 *e*. Wide distal fragment. Ettrickbridge End, S. Scotland. Band of *R. maximus*. Geological Survey of Scotland.

8 *f*. Proximal fragment, preserved mainly as a low cast, probably referable to this species. Quarry S. side main road from Devil's Bridge to Rhayader, 200 yards S. of Bodcoll Farm. Castell Group. Geological Survey of England and Wales.

9 *a*, *b*.—*Monograptus M'Coyi*, Lapworth. (Page 446.)

9 *a*. Type specimen, figured Lapworth, Graptolites of Co. Down, 1877, pl. vi, fig. 2. Tieveshilly, Co. Down. Belfast Natural History Museum.

9 *b*. Wide fragment, possibly referable to this species. Belcraig Burn, near Moffat. Band of *R. maximus*. Lapworth's Collection.

10 *a*—*f*.—*Monograptus Sedgwickii* (Portlock). (Page 441.)

10 *a*. Typical distal fragment, with conspicuous apertural spines. Pomeroy, co. Tyrone. Upper Llandovery Beds. British Museum (Natural History), S. Kensington.

10 *b*. Proximal fragment, on same slab as fig. 10 *a*.

10 *c*. Proximal fragment, showing sicula. Sundhope-on-Yarrow, S. Scotland. Upper Birkhill Shales. Lapworth's Collection.

10 *d*. Broad specimen, with conspicuous apertural spines. Glenkiln Burn, S. Scotland. Upper Birkhill Shales. Lapworth's Collection.

10 *e*. Specimen with slightly recurved proximal end. Duffkinnel Burn, Wamphray. Upper Birkhill Shales. British Museum (Natural History).

10 *f*. Long fragment, with concave curvature, apertural spines concealed for the most part. On same slab as fig. 10 *e*.

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MONOGRAPTUS.

PLATE XLV.

Monograptus—*continued.*

FIGS.

1 *a—f.*—*Monograptus lobiferus* (M'Coy). (Page 448.)

1 *a*. Counter-impression of type specimen, figured M'Coy, Brit. Pal. Fossils, pl. i B, figs. 3 and 3 *a*. Moffat. Sedgwick Museum.

1 *b*. Narrower and more proximal fragment, figured Lapworth, Geol. Mag., 1876, pl. xx, fig. 1 *a*. Craigierig, S. Scotland. Birkhill Shales. Lapworth's Collection.

1 *c*. Long fragment, somewhat broken. Long Linn, Dobb's Linn. Upper Birkhill Shales. Elles' Collection.

1 *d*. Wider distal fragment, irregularly flexed. Ibid.

1 *e*. Proximal fragment, showing sicula, preserved in relief. Ten yards up stream from crest of anticline, N. of Fuches-gau Farmhouse. Castell Group. Geological Survey of England and Wales.

1 *f*. Broad fragment, with unusually strong concave curvature. Duffkinnel, above Glanhall, S. Scotland. Birkhill Shales. Geological Survey of Scotland, Edinburgh.

2 *a—g.*—*Monograptus runcinatus*, Lapworth. (Page 450.)

2 *a*. Proximal fragment, in relief, showing sicula. Glenkiln Burn, S. Scotland. Upper Birkhill Shales. Lapworth's Collection.

2 *b*. Similar specimen, in low relief. River Twymyn, Llanbrynmair. Brynmair Beds. Wood's Collection.

2 *c*. Longer proximal fragment. Glenkiln Burn. Upper Birkhill Shales. Lapworth's Collection.

2 *d*. Similar specimen. Ibid.

2 *e*. Long and curved distal fragment, preserved as a low cast, figured Lapworth, Geol. Mag., 1871, pl. xx, fig. 4 *c*. Ibid.

2 *f*. Rather more rigid specimen. E. side Upper Quarry, 30 yards E. of Fuches-gau Farmhouse. Geological Survey of England and Wales.

2 *g*. Two specimens crossing one another. W. side Upper Quarry, 550 yards E. of Fuches-gau Farmhouse. Geological Survey of England and Wales.

3 *a—g.*—*Monograptus runcinatus*, var. *pertinax*, Elles and Wood, nov. (Page 451.)

3 *a*. Proximal fragment, showing sicula, preserved in relief. Gelli-dwyll Stream, below farmhouse, near Llanbrynmair. Brynmair Beds. Wood's Collection.

3 *b*. Similar specimen. On same slab as fig. 3 *a*.

3 *c*. Distal fragment, preserved mainly as a cast. Same locality.

3 *d*. Broader fragment, with slight curvature, preserved in relief. Ibid.

3 *e*. Long fragment imperfectly preserved. Ibid.

3 *f*. Long fragment, probably referable to this variety. Buckholm Side, Galashiels. Gala Beds. Geological Survey of Scotland.

3 *g*. Proximal fragment. Same locality as fig. 3 *a* and *c*.

4 *a—f.*—*Monograptus Becki* (Barrande). (Page 452.)

4 *a*. Typical specimen, figured Lapworth, Geol. Mag., 1876, pl. xx, fig. 2 *a*. Meigle Quarry, Galashiels. Gala Beds. Lapworth's Collection.

4 *b*. Similar specimen. On same slab as fig. 4 *a*.

4 *c*. Long curved distal fragment. Same locality as above.

4 *d*. Specimen with long tapering proximal portion. Portaferry, Co. Down. Tarannon Beds. Swanston's Collection, Belfast.

4 *e*. Similar specimen. On same slab as fig. 4 *d*.

4 *f*. Distal fragment. River Twymyn, near Llanbrynmair. Brynmair Beds. Wood's Collection.

5.—*Monograptus undulatus*, Elles and Wood, sp. nov. (Page 432.)

Specimen, showing sicula, preserved in relief. E. side of quarry, N.E. of Fagwr-fawr Farmhouse, Pont Erwyd. Geological Survey of England and Wales.

6 *a—f.*—*Monograptus crispus*, Lapworth. (Page 456.)

6 *a*. Type specimen, figured Lapworth, Geol. Mag., 1876, pl. xx, fig. 7 *a*. Meigle Quarry, Galashiels. Gala Beds. Lapworth's Collection.

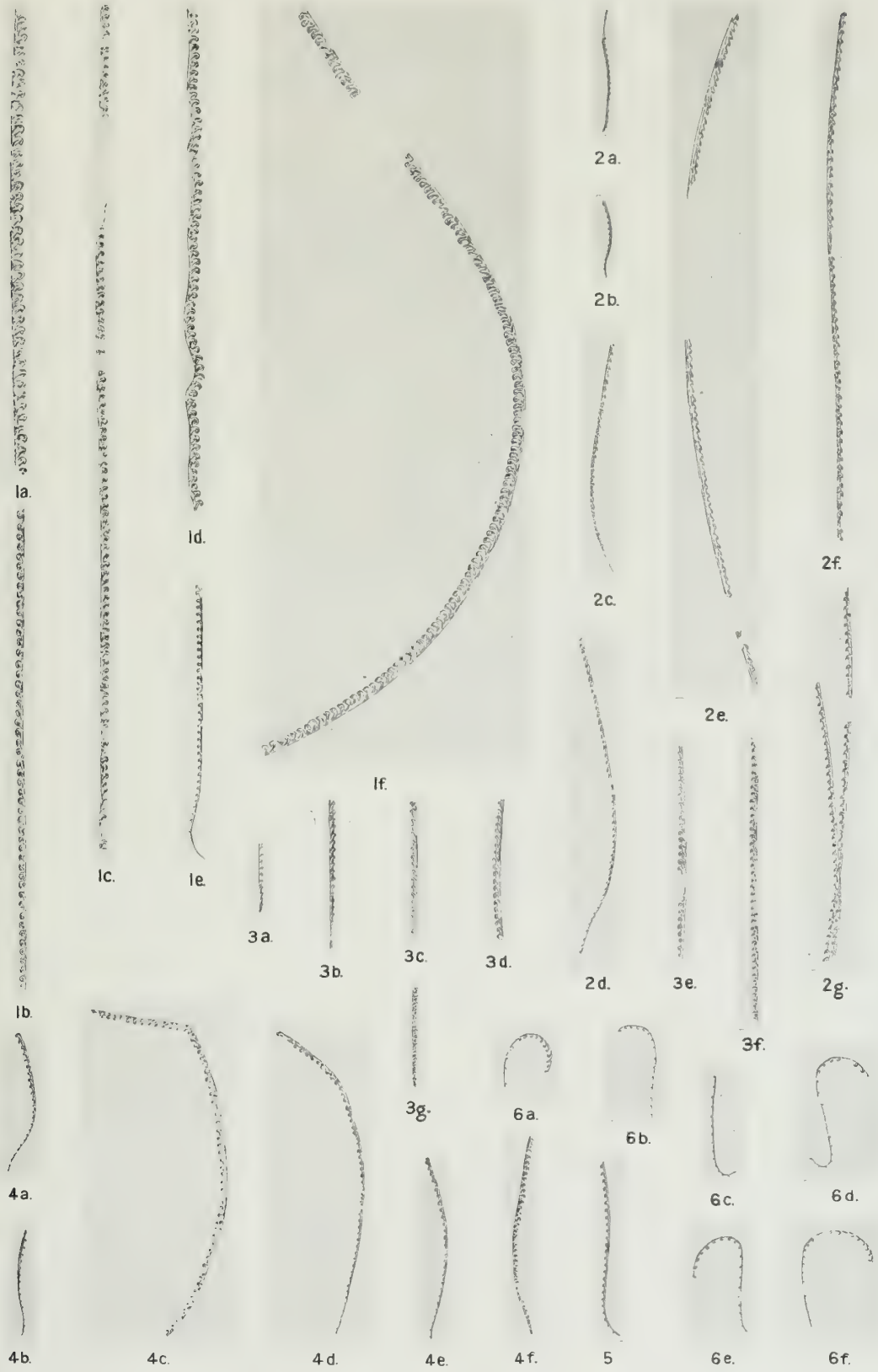
6 *b*. Proximal portion. On same slab as fig. 6 *a*.

6 *c*. Proximal portion, showing sicula. Same locality as above.

6 *d*. Complete specimen, showing characteristic form of polypary. Tieveshilly, co. Down. Gala Beds. Lapworth's Collection.

6 *e*. Typical specimen. Portaferry, Ireland. Belfast Natural History Museum.

6 *f*. Large fragment. Same locality as fig. 6 *d*.



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MONOGRAPTUS.

PLATE XLVI.

Monograptus—*continued.*

FIGS.

1 *a*—*d*.—*Monograptus exiguus* (Nicholson). (Page 453.)

1 *a*. Group of typical specimens, figured Lapworth, Geol. Mag., 1876, pl. xx, fig. 6 *a*. Caddonfoot Quarry, S. Scotland. Gala Beds. Lapworth's Collection.

1 *b*. Two fragments crossing one another. Caddon Head, S. Scotland. Gala Beds. Lapworth's Collection.

1 *c*. Complete specimen. Portaferry, Co. Down. Gala Beds. Belfast Natural History Museum.

1 *d*. Long distal fragment, preserved in relief. Bont Green, River Twymyn, Llanbrynmair. Brynmair Beds. Wood's Collection.

2 *a*—*d*.—*Monograptus nodifer*, Törnquist. (Page 454.)

2 *a*. Typical specimen. Cefn Hendre Quarry, about 150 yds. E. of farm, $1\frac{1}{2}$ miles E. of Aberystwith. Geological Survey of England and Wales.

2 *b*. Smaller, but typical specimen. Ibid.

2 *c*. Small specimen. Ibid.

2 *d*. Specimen on same slab as fig. 2 *c*.

3.—*Monograptus flagellaris*, Törnquist. (Page 457.)

Specimen probably referable to this species. Blythe Water, near Lauder, S. Scotland. Gala Beds. Geological Survey of Scotland.

4 *a*—*d*.—*Monograptus capillaceus*, Tullberg. (Page 458.)

4 *a*. Characteristic specimen. Streamlet at Grange, Milk Water, 6 miles N.E. of Ecclefechan, S. Scotland. Wenlock Beds. Geological Survey of Scotland.

4 *b*. Proximal fragment. On same slab as fig. 4 *a*.

4 *c*. Distal fragment. On same slab as figs. 4 *a* and *b*.

4 *d*. Distal fragment. Milk Water at Milkbridge, 3 miles S. of Lockerbie, S. Scotland. Geological Survey of Scotland.

5 *a*—*c*.—*Monograptus retroflexus*, Tullberg. (Page 459.)

5 *a*. Proximal fragment. Quarry near Nant Prophwyd, Builth. Wenlock Shales (zone of *Cyrtog. rigidus*). Elles' Collection.

5 *b*. Small proximal fragment. Ibid.

5 *c*. Distal fragment. Ibid.

6 *a*, *b*.—*Monograptus Barrandei* (Suess). (Page 462.)

6 *a*. Specimen, figured Lapworth, Graptolites of Co. Down, 1877, pl. v, fig. 21. Tieveshilly, Co. Down. Tieveshilly Beds. Lapworth's Collection.

6 *b*. More proximal fragment, figured Lapworth, Geol. Mag., 1876, pl. xx, figs. 5 *a* and *b*. Buckholm, Galashiels. Gala Beds. Lapworth's Collection.

FIGS.

7 *a—d.*—*Monograptus dextrorsus*, Linnarsson. (Page 460.)

7 *a*. Long distal fragment. Afon Cwm Calch, near Talerddig, Montgomeryshire. Upper Talerddig Beds. Wood's Collection.

7 *b*. Irregularly bent specimen. Ibid.

7 *c*. Long curved specimen. Ibid.

7 *d*. Specimen showing proximal end, probably referable to this species. Llanystwmdwy. Fearnsides' Collection.

8 *a*, *b*.—*Monograptus knockensis*, Elles and Wood, sp. nov. (Page 462.)

8 *a*. Distal fragment. Knock, Edenside. Browgill Beds. Marr's Collection.

8 *b*. Smaller fragment. Ibid.

9 *a*, *b*.—*Monograptus remotus*, Elles and Wood, sp. nov. (Page 461.)

9 *a*. Type specimen. Rigg Burn, River Esk, 6 miles N.N.W. of Langholm. Gala Beds. Geological Survey of Scotland.

9 *b*. Co-type specimen. Ibid.

10 *a—d.*—*Monograptus millepeda* (M'Coy). (Page 465.)

10 *a*. Typical specimen, preserved in relief. Skelgill, Lake District. Skelgill Beds. Sedgwick Museum.

10 *b*. Specimen, preserved in partial relief. Skelgill. Skelgill Beds. British Museum (Natural History), S. Kensington.

10 *c*. Well preserved, but incomplete specimen. Skelgill. Skelgill Beds (zone of *Monog. argenteus*). Marr's Collection.

10 *d*. Large, but incomplete specimen, figured Lapworth (as *M. lobiferus*, var. *Nicoli*), Geol. Mag., 1876, pl. xx, fig. 1 *c*. Dobb's Linn. Birkhill Shales. Lapworth's Collection.

11 *a—f.*—*Monograptus Clingani* (Carruthers). (Page 463.)

11 *a*. Type specimen, figured Carruthers, Geol. Mag., 1868, pl. v, fig. 19 *a*. Duffkinnel (?). Birkhill Shales. British Museum (Natural History), S. Kensington.

11 *b*. Co-type specimen, figured Carruthers, loc. cit. supra, fig. 19 *b*.

11 *c*. Characteristic specimen, showing sicula. Moory Syke, S. Scotland. Birkhill Shales. Lapworth's Collection.

11 *d*. Very long specimen, with broadly recurved proximal portion, figured Lapworth, Geol. Mag., 1876, pl. xx, fig. 3 *a*. Dobb's Linn. Birkhill Shales. Lapworth's Collection.

11 *e*. Small specimen. Dobb's Linn. Sedgwick Museum.

11 *f*. Specimen, preserved in partial relief, thecæ somewhat embedded, E. side Quarry, N.E. of Fagwr-fawr Farm, Pont Erwyd (zone of *Monog. convolutus*). Geological Survey of England and Wales.

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MONOGRAPTUS.

PLATE XLVII.

Monograptus—*continued.*

FIGS.

1 *a—d.*—*Monograptus convolutus* (Hisinger). (Page 467.)

1 *a*. Very large specimen, showing *Rastrites*-like character of the proximal thecæ. Figured Carruthers, Geol. Mag., 1868, pl. v, fig. 1 *a*. Dobb's Linn. Birkhill Shales. Geological Survey of England and Wales.

1 *b*. Smaller, but well preserved specimen. Pishnack Burn, Wee Queensberry. Birkhill Shales. Geological Survey of Scotland.

1 *c*. Incomplete specimen, but showing well the *Rastrites*-like character of the proximal thecæ. Plewlands Burn, Raehills. Birkhill Shales. Geological Survey of Scotland.

1 *d*. Less well preserved specimen. Duffkinnel Burn, Wamphray. Birkhill Shales. British Museum (Natural History), S. Kensington.

2 *a, b.*—*Monograptus delicatulus*, Elles and Wood, sp. nov. (Page 478.)

2 *a*. Typical specimen. Sundhope-on-Yarrow. Birkhill Shales (zone of *Monog. gregarius*). Lapworth's Collection.

2 *b*. Good specimen, showing character of proximal thecæ. The Corrie, Dobb's Linn. Birkhill Shales. Elles' Collection.

3 *a—e.*—*Monograptus decipiens*, Törnquist. (Page 469.)

3 *a*. Two specimens crossing one another. Long Linn, Dobb's Linn. Birkhill Shales (zone of *Monog. gregarius*). Elles' Collection.

3 *b*. Specimen broadly curved. E. side quarry, N.E. of Fagwr-fawr Farm, Pont Erwyd. Geological Survey of England and Wales.

3 *c*. Specimen irregularly curved, preserved in full relief. Dobb's Linn. Birkhill Shales. Geological Survey of Scotland.

3 *d*. Specimen with rather longer thecæ. Dobb's Linn. Birkhill Shales. Sedgwick Museum.

3 *e*. Small specimen. Clanyard Bay, Port Logan. Birkhill Shales. Geological Survey of Scotland.

4 *a—f.*—*Monograptus triangulatus* (Harkness). (Page 471.)

4 *a*. Specimen preserved in full relief. 430 yds. S.S.E. of Bryn-chwîth Farmhouse, Pont Erwyd. Zone of *Monog. triangulatus*. Geological Survey of England and Wales.

4 *b*. Fairly complete specimen. Donaghadee. Birkhill Shales. Belfast Natural History Museum.

4 *c*. Large fragment. Dobb's Linn. Birkhill Shales. Geological Survey of Scotland.

4 *d*. Fairly complete specimen. Ibid.

4 *e*. Specimen, preserved mainly as a cast. Rheidol Gorge, Pont Erwyd. Jones' Collection.

4 *f*. Very large specimen, irregularly bent, preserved mainly as a cast, with thecæ partly embedded. Dobb's Linn. Birkhill Shales. Dairon's Collection, Kelvingrove Museum, Glasgow.

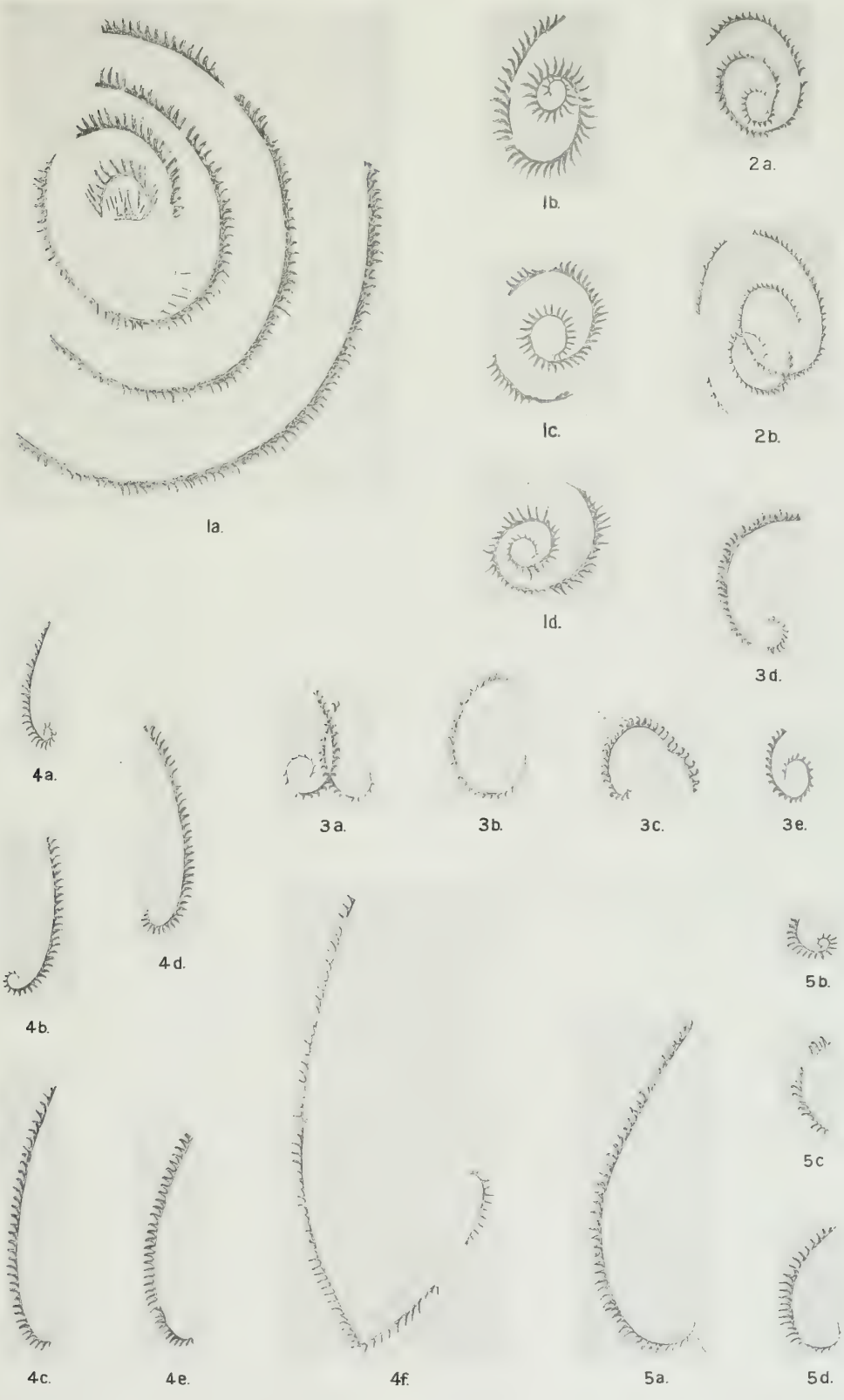
5 *a—d.*—*Monograptus triangulatus*, var. *major*, Elles and Wood, nov. (Page 472.)

5 *a*. Typical specimen. Garple Linn, near Moffat. Birkhill Shales. British Museum (Natural History), South Kensington.

5 *b*. Small proximal fragment. Dobb's Linn. Birkhill Shales. Elles' Collection.

5 *c*. Small fragment, preserved as a cast. 430 yds. S.S.E. of Bryn-chwîth Farmhouse. Geological Survey of England and Wales.

5 *d*. Specimen showing great length of thecæ. Dobb's Linn. Birkhill Shales. Elles' Collection.



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MONOGRAPTUS.

PLATE XLVIII.

Monograptus—*continued.*

FIGS.

1 *a—d.*—***Monograptus urceolus***, Richter. (Page 470.)

1 *a*. Group of proximal fragments, associated with a specimen of *Rastrites*. Duffkinnel, Wamphray. Birkhill Shales. Geological Survey of Scotland, Edinburgh.

1 *b*. Two specimens showing change in character of thecæ. Belcraig Burn. Birkhill Shales. Dairon's Collection, Kelvingrove Museum, Glasgow.

1 *c*. Specimen, showing character of distal thecæ. On same slab as fig. 1 *b*.

1 *d*. Group of specimens. Belcraig Burn. Birkhill Shales. Geological Survey of Scotland.

2 *a—f.*—***Monograptus denticulatus***, Törnquist. (Page 474.)

2 *a*. Typical specimen, preserved in relief. Skelgill Beck, Ambleside. Skelgill Beds. Elles' Collection.

2 *b*. Similar specimen, preserved in partial relief. Skelgill Beck, Ambleside. Skelgill beds. British Museum (Natural History), S. Kensington.

2 *c*. Specimen with broader curve. Long Linn, Dobb's Linn. Birkhill Shales (band of *Cephalog. cometa*). Elles' Collection.

2 *d*. Long specimen. Ibid.

2 *e*. Small specimen with broad curve. Skelgill Beck, Ambleside. Skelgill Beds. British Museum (Natural History).

2 *f*. Fragment closely resembling one of Törnquist's figured specimens (loc. cit. supra, fig. 21), but doubtfully referable to this species. Elwand Bank, near Melrose. Lapworth's Collection.

3 *a—c.*—***Monograptus raitzhainiensis*** (Eisel). (Page 473.)

3 *a*. Good specimen, preserved in partial relief. Rheidol Gorge, Pont Erwyd. Zone of *Monog. communis* (Jones) Jones' Collection.

3 *b*. Smaller and less complete specimen. Skelgill Beck ? Sedgwick Museum.

3 *c*. Distal fragment, less certainly referable to this species. 430 yds. S.S.E. of Bryn-chwîth Farmhouse. Band of *Mesog. magnus*. Geological Survey of England and Wales.

4 *a—d.*—***Monograptus fimbriatus*** (Nicholson). (Page 482.)

4 *a*. Typical specimen, preserved in partial relief. Skelgill Beck. Skelgill Beds. Sedgwick Museum.

4 *b*. Small specimen, showing proximal thecæ. Dobb's Linn. Lower Birkhill Shales. Geological Survey of Scotland.

4 *c*. Large specimen with characteristic proximal thecæ. Garple Linn, near Moffat. Lower Birkhill Shales. Geological Survey of Scotland.

4 *d*. Very long specimen, incomplete proximally, somewhat distorted. On same slab as fig. 4 *b*.

PLATE XLVIII—*continued.*

FIGS.

5 *a*—*d*.—*Monograptus fimbriatus*, var. *similis*, Elles and Wood, var. nov. (Page 483.)

5 *a*. Small specimen, showing short proximal end. Dobb's Linn. Birkhill Shales. Lapworth's Collection.

5 *b*. Somewhat wider specimen. Ibid.

5 *c*. Small specimen showing sicula. Dobb's Linn. Birkhill Shales. Sedgwick Museum.

5 *d*. Long specimen, but incomplete proximally. On same slab as fig. 5 *b*.

6 *a*—*d*.—*Monograptus planus* (Barrande). (Page 484.)

6 *a*. Specimen, preserved in partial relief. Plas-bach Stream, near Llanbrynmair. Junction beds of the Dolgau and Nant-ys-gollen Shales. Wood's Collection.

6 *b*. Small specimen, showing proximal end. Dobb's Linn. Geological Survey of Scotland.

6 *c*. Characteristic specimen. Hebblethwaite Gill, Lake District. Browgill Beds. Sedgwick Museum.

6 *d*. Larger and broader specimen. Dobb's Linn. Geological Survey of Scotland.

7 *a*—*d*.—*Monograptus spiralis* (Geinitz). (Page 475.)

7 *a*. Small specimen, showing proximal thecæ. Tarannon River, Montgomeryshire. Gelli Beds. Wood's Collection.

7 *b*. Large specimen with characteristic irregular curvature. Portaferry, Co. Down. Gala Beds. Belfast Natural History Museum.

7 *c*. Incomplete specimen. Thirlstane Score, near Moffat. Band of *Rastrites maximus*. Lapworth's Collection.

7 *d*. Very regularly curved specimen, but probably referable to this species, true thecal form concealed for the most part. Nant Fuches-wen, Pont Erwyd. Jones' Collection.

8 *a*—*c*.—*Monograptus proteus* (Barrande). (Page 477.)

8 *a*. Specimen, showing typical form of polypary. Bont Dolgadfan, near Llanbrynmair. Brynmair Beds. Wood's Collection.

8 *b*. Similar specimen, but with longer proximal portion. Portaferry, Co. Down. Tarannon Beds. Swanston's Collection, Belfast.

8 *c*. Group of distal fragments, showing form of thecæ. Gelli-dywyll Stream, near Llanbrynmair. Brynmair Beds. Wood's Collection.

9 *a*, *b*.—*Monograptus circularis*, Elles and Wood, sp. nov. (Page 479.)

9 *a*. Typical specimen. Plewlands Burn, Raehills. Upper Birkhill Shales. Geological Survey of Scotland.

9 *b*. Less well-preserved specimen. Ibid.

1a.

1b.

2a.

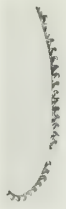
2b.

2c.

3a.

1c.

1d.


2d.

2e.

2f.

3b.

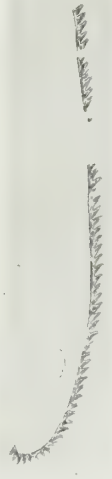
5c.

6a.

3c.

4a.

4c.


4d.

5a.

5b.

5d.

6b.

6c.

6d.

4b.

7a.

7b.

7c.

8a.

8b.

8c.

7d.

9a.

9b.

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MONOGRAPTUS.

PLATE XLIX.

Monograptus—*continued.*

FIGS.

1 *a*—*e*.—*Monograptus communis* (Lapworth). (Page 480.)

1 *a*. Type specimen, figured Lapworth, Geol. Mag., 1876, pl. xiii, fig. 4 *a*. Dobb's Linn. Birkhill Shales. Lapworth's Collection.

1 *b*. Well-preserved specimen, in partial relief. Rheidol Gorge, Pont Erwyd. Jones' Collection.

1 *c*. Typical specimen. Dobb's Linn. Birkhill Shales. Sedgwick Museum.

1 *d*. Form with wide proximal curve, intermediate in character between *M. communis* and *M. millepeda*. Ibid.

1 *e*. Curiously curved specimen, provisionally referred to this species, preserved in partial relief. Dobb's Linn (?) British Museum (Natural History), South Kensington.

2 *a*—*c*.—*Monograptus communis*, var. *rostratus*, Elles and Wood, var. nov. (Page 481.)

2 *a*. Typical specimen, showing long proximal thecæ. Dobb's Linn. Birkhill Shales. Lapworth's Collection.

2 *b*. Well preserved and typical specimen. Dobb's Linn. Birkhill Shales. Geological Survey of Scotland.

2 *c*. Specimen with more abrupt proximal curvature. On same slab as fig. 2 *b*.

3 *a*—*c*.—*Monograptus intermedius* (Carruthers). (Page 485.)

3 *a*. Portion of slab, showing mode of occurrence. Sundhope-on-Yarrow, S. Scotland. Birkhill Shales. Lapworth's Collection.

3 *b*. Single proximal fragment. Ibid.

3 *c*. Distal fragment. Ibid.

4 *a*—*c*.—*Monograptus involutus* (Lapworth). (Page 478.)

4 *a*. Portion of slab, showing mode of occurrence. Sundhope-on-Yarrow. Birkhill Shales. Lapworth's Collection.

4 *b*. Single specimen. Dobb's Linn (?). Birkhill Shales. Lapworth's Collection.

4 *c*. Small fragment, showing form of polypary. W. side old quarry, N.E. of Fagwr-fawr, 2 miles E.N.E. of Pont Erwyd. Geological Survey of England and Wales.

5 *a*—*c*.—*Monograptus* cfr. *elongatus*, Tornquist. (Page 486).

5 *a*. Fragment. Llanystwmdwy, near Criccieth. Llandovery Beds. Fearnsides' Collection.

5 *b*. Small fragment. Ten yds. up stream from crest of anticline, N. of Fuches-gau Farmhouse, Pont Erwyd. Geological Survey of England and Wales.

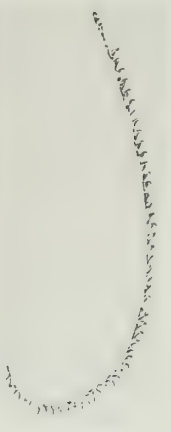
5 *c*. Small proximal fragment. Rheidol Gorge, 440 yds. S.S.E. of Bryn-chwîth Farmhouse, Pont Erwyd. Geological Survey of England and Wales.

1a.

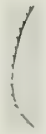
1b.

1c.

1d.



2a.

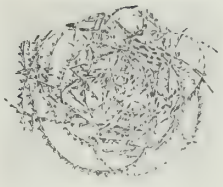


3b.

3c.

2b.

3a.



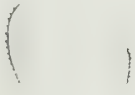
4a.

1e.

4c.

5a.

4b.



5b.

5c.

2c.

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Bemrose, Collo., Derby.

MONOGRAPTUS.

Palæontographical Society, 1912.

A MONOGRAPH

OF THE

BRITISH CAMBRIAN TRILOBITES.

BY

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PART IV.

Pages 65—88; Plates VII—X.

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more or less outward, the posterior pleuræ but little if at all facetted, and ending in short falcate points which curve backwards.

Tail rather large, broad, semi-circular, marginate. Axis narrow, about one-fifth the total width, ending in a point which reaches the posterior margin, with three definite rings, and a fourth somewhat indistinctly marked off from the terminal conical portion. Lateral lobes with four grooves similar to the pleural grooves, and fine intermediate impressed lines which are especially distinct near the margin. Margin narrow, uniform in width, flat or slightly concave.

An enlarged figure of the tail has been added on Plate VII (fig. 1).

Dimensions.—Length of the figured specimen 36·5 mm.

This form is readily distinguished from *Olenus longispina* by the greater length of the glabella and the much larger tail with the peculiar conical termination to the axis. It closely resembles *P. cæsa*, but in that species there are three pairs of glabellar furrows instead of two, and the conical termination to the axis of the tail is absent or rudimentary.

Most of the other species of *Parabolinella* have the glabella more truncate, and as a rule they possess at least three pairs of glabellar furrows, but the first pair is not always distinct. In most species also the tail is much smaller than in either *P. williamsoni* or *P. cæsa*.

It should be noted that the presence or absence of median tubercles on the thoracic axis or neck-ring is not a reliable character in this genus. Even amongst the well-preserved Shineton Shale fossils many of the specimens of *P. triarthra* show no tubercles, whilst in others, and especially in external casts, the tubercles are quite distinct.

The specimen figured was named by Salter *Olenus planti*, and has since been fully described under that name by Mr. F. R. C. Reed, who referred it to the section *Parabolinella*, and pointed out the resemblance to Belt's *Conocoryphe williamsoni*. Comparison with the specimens of that species in Belt's collection in the British Museum has led me to conclude that the two forms are identical. Unfortunately none of these specimens are complete. They include, however, cranidia and tails. The tails are identical with that of the specimen here described, and the only difference in the cranidia is that the frontal margin is sometimes more angulate. The facial sutures seem to have united along this margin, and in some cases the anterior horns of the free cheeks have been broken off.

The head-shield with attached free cheek from Craig-y-Dinas, referred to by Mr. Reed, may possibly belong to this species. The specimen, however, is very obscure, and the glabella appears to extend forwards to the anterior margin.

Horizon and Localities.—Upper Lingula Flags: Moel Gron; Dolgelly.

2. **Parabolinella cæsa**, sp. nov. Plate VII, fig. 2.

Glabella almost rectangular, narrowing slightly forwards, with the anterior angles rounded, separated from the marginal furrow by a space rather less than one-fourth the length of the glabella; three pairs of glabellar furrows, none of which reach either the middle line or the axial groove; the first pair short, nearly at right angles to the axis; the second pair longer and more oblique; the third pair sigmoid, giving off towards the side a small posterior branch; neck-furrow shallow towards the middle, neck-segment with very indistinct traces of a median tubercle. Eyes placed about halfway between the anterior and posterior margins, very near to the glabella; ocular ridge short and slightly oblique. Facial suture running backwards and inwards to the eye and thence backwards and outwards. Margin formed by a narrow raised rim.

Thorax of sixteen segments. Axis as wide as the pleuræ in the front part of the thorax, but in the hinder part not much more than half their width; no median tubercles visible. Pleuræ nearly straight and horizontal, bent very slightly downwards and backwards at the fulcrum, which in the anterior pleuræ is about halfway out, in the later segments becomes gradually farther out and less distinct; pleural grooves oblique, the anterior pleuræ facetted and terminating in short points directed outwards, the later pleuræ not facetted and ending in short falcate points which curve backwards.

Tail fairly large, semicircular, marginate. Axis forming less than one-fourth the total width, ending bluntly some distance from the margin, but connected with the margin by a faint ridge; three distinct rings besides the terminal portion. Lateral lobes wide, with three furrows, interlined. Margin narrow.

Dimensions.—About 20 mm. long.

A comparison of this description with that of *Parabolinella williamsoni* will show at once that the two forms are very closely allied, and it is with some hesitation that I separate them, for the differences may be due in part to the mode of preservation. The specimen here described has been compressed from front to back; the specimen of *P. williamsoni* has hardly been compressed at all and only slightly distorted. *P. williamsoni*, however, has only two pairs of glabellar furrows with no trace of a third, while in *P. cæsa* the three pairs are quite distinct, and the last pair shows the branching which is seen in several other species of *Parabolinella* but not in *P. williamsoni*. In their general form the tails of the two species are similar, but in *P. williamsoni* the axis ends in a cone which reaches the margin, in *P. cæsa* it ends bluntly, and the rounded termination is connected with the posterior margin by a slightly raised narrow ridge. The margin appears to be narrower in *P. cæsa*, but this is probably because it is less perfectly preserved.

Horizon and Locality.—Upper Lingula Flags: Dolgelly.

3. **Parabolinella rugosa**, Brögger, var. Plate VII, fig. 3.

1882. *Parabolinella rugosa*, Brögger, Die Silur. Etagen 2 und 3, p. 104, pl. iii, fig. 3.
1896. *Parabolinella*, sp. nov., Crosfield and Skeat, Quart. Journ. Geol. Soc., vol. lii, p. 537, pl. xxvi, figs. 11, 12.

Glabella almost square, narrowing slightly towards the front. Four pairs of glabellar furrows; the first pair nearly parallel to the neck-furrow, somewhat sinuous; the second pair rather more oblique and also rather sinuous; the third pair strongly curved, the convexity directed forwards, giving off a posterior branch towards the axial groove; posterior furrows nearly straight and nearly at right angles to the axis, bifurcating inwards, a narrow ridge being enclosed between the branches. Neck-segment divided by a groove passing from one posterior lateral angle to the middle of the neck-furrow and thence to the other posterior lateral angle, a small tubercle on the middle portion thus separated off. Eye placed very near to the glabella, large, extending from the second nearly to the last glabellar furrow; ocular ridge very short, reaching the axial groove close to the first glabellar furrow. Facial suture incompletely shown, but the posterior branch runs nearly parallel to the posterior margin to a distance from the glabella about equal to three-quarters of the width of the latter; it then turns back to cut the margin.

This specimen was originally described and figured by Misses Crosfield and Skeat, who compared it with Brögger's *P. rugosa* and came to the conclusion that it presented sufficient differences to be considered a new species or variety. Owing, however, to the imperfection of the specimen they did not give it a name. Whether it is identical or not with *P. rugosa*, it is certainly very closely allied to that species, and such differences as there are may be due to differences in the mode of preservation. Until more perfect material has been obtained, therefore, I prefer to consider it a variety rather than a distinct species.

The glabella is wider in proportion to its length than in *P. rugosa*, but this is clearly the result of compression. The only difference of importance is the peculiar forking of the last pair of glabellar furrows. In such a specimen it is difficult to distinguish between adventitious wrinkles and original furrows, but the fact that both the right and the left furrows show the forking certainly suggests that it is original. Brögger makes no mention of any such forking; but his specimen is from the Ceratopyge Limestone and may possibly show the actual test, while the specimen of Misses Crosfield and Skeat is an internal cast. Moreover, a very similar cranidium has been obtained from the same beds by the Geological Survey, and in this there is no forking of the fourth pair of furrows. The precise form of the glabellar furrows in such specimens as these evidently depends in part upon the crushing to which they have been subjected. Misses Crosfield and Skeat remark on the absence of a median tubercle on the neck-segment in their specimen;

but traces of such a tubercle are present, as distinct as they usually are in so crushed a specimen.

None of the other species of *Parabolinella* known in Britain have four pairs of glabellar furrows.

Horizon and Localities.—Tremadoc Slates: Nant-y-Glas-dwr and Allt Pen-y-Coed dingle, near Carmarthen.

4. **Parabolinella triarthra** (Callaway). Plate VII, figs. 4—12.

1877. *Olenus triarthrus*, Callaway, Quart. Journ. Geol. Soc., vol. xxxiii, p. 666, pl. xxiv, fig. 6.

Head semi-circular, somewhat angulate in front, with the genal angles produced into long spines. Glabella almost square, a little wider in front than behind; anterior border slightly emarginate, separated from the marginal rim by a broad frontal limb; three pairs of glabellar furrows; the first pair often obsolete in small specimens, in larger specimens consisting of (1) a very short deeply impressed groove opening into the axial furrow and directed obliquely forwards and inwards, (2) a much shallower and disconnected furrow nearer the central line of the glabella and slightly further back; the second pair of glabellar furrows somewhat sinuous or irregular in form, directed obliquely backwards, not quite reaching either the axial furrow or the middle line of the glabella; the third pair somewhat similar but towards the axial furrow bifurcating, the posterior branch being but faintly impressed; neck-segment well defined throughout, sometimes divided as in *P. rugosa*, and bearing a median tubercle. Eyes small, placed nearer to the anterior than to the posterior margin, very close to the glabella, a short ocular ridge running from the eye towards the anterior angles of the glabella. Facial suture running from the anterior margin backwards and very slightly inwards to the eye, and thence outwards and backwards almost in a straight line to the posterior margin, which it cuts at a distance from the axial furrow rather less than the width of the glabella. Frontal limb broad, about one third the length of the glabella; fixed cheeks narrow in front of the eye, widening rapidly backwards, with a strong neck-furrow; free cheeks of moderate width, marginate, sloping downwards from the eye. Head surrounded by a narrow marginal rim and furrow, the furrow in front of the cranidium being marked by a row of small pits; genal angles produced into long spines which extend backwards nearly two-thirds the length of the thorax.

Thorax with a variable number of segments, but in the larger specimens usually twenty-one, of which the last is more or less firmly attached to the tail. Axis tapering slowly and regularly from front to back so that the axial furrows are nearly straight; forming rather less than one-third the total width, being relatively narrowest about the middle of the body; each segment with a median tubercle,

which is not always very distinct. Anterior pleuræ with the fulcrum placed about one-third of their length, or less, from the axis, the portion outside the fulcrum bent slightly downwards and backwards, the ends produced into short points; in the later segments the fulcrum becomes progressively less marked, and the ends less and less pointed until in the last two or three they are completely rounded; pleural grooves narrow.

Tail very small, width nearly three times its length, margin entire. Axis forming about one-third of the total width, consisting of one ring and a terminal portion, ending bluntly, not quite reaching the posterior margin. Lateral lobes marked by two furrows.

Dimensions.—The large specimen shown in Plate VII, fig. 4, would, if complete, be about 65 mm. long, and there is a cranidium of a considerably larger individual in the Sedgwick Museum. A length of thirty or forty millimetres is, however, more usual.

The boundary between tail and thorax is not perfectly definite. The twenty-first segment seems to be loosely attached to the tail; the pleural portion easily comes apart, but the axial ring is more firmly united. Sometimes the axial ring of the twentieth segment also seems to be joined to the tail.

The pits in the marginal furrow are seldom visible and the first pair of glabellar furrows is often indistinct or obsolete. The median tubercles on the axis are usually inconspicuous on internal casts and sometimes appear to be absent; they are better shown on external moulds. All these differences are evidently due to the state of preservation.

There is more danger of confusing this species with *Triarthrus shinetonensis* than with any other species of its own genus. It differs from *P. williamsoni* and *P. cæsa* in the emargination of the front of the glabella as well as in the glabellar furrows; from *P. rugosa* in the smaller number of glabellar furrows; and from *Triarthrus shinetonensis* in the much wider frontal limb. The large number of segments distinguishes the thorax from *P. williamsoni* (with about fifteen), *P. cæsa* (with sixteen), and *Triarthrus shinetonensis* (with fourteen); and from the latter it is also separated by the absence of the long spine on the twelfth segment and by the comparative weakness of the pleural grooves. The tail is much smaller than in *P. williamsoni* and *P. cæsa*, but is not unlike that of *Triarthrus shinetonensis*; in the last, however, there are two distinct rings on the axis, and the furrows on the lateral lobes are stronger.

The specimens shown in Plate VII, figs. 10 and 11 differ in some respects from the typical form, but the differences are perhaps due to age. The glabella is more nearly parallel-sided and more rounded in front, with the first pair of glabellar furrows almost invisible; the facial suture runs more obliquely inwards from the anterior margin to the eye; the pleural grooves are stronger, more like those of

Triarthrus shinetonensis, but that the specimens do not belong to the latter species is clearly shown by the breadth of the frontal limb.

A young form, presumably belonging to this species, is shown in Plate VII, fig. 12. It has, apparently, eight thoracic segments, but otherwise does not differ very greatly from the adult. The head, unfortunately, is incomplete.

Horizon and Locality.—Shineton Shales: Shineton.

Genus **TRIARTHRUS**, Green.

The type of this genus is *Triarthrus becki*, Green,[1] and the prominent features of that form are the large glabella reaching nearly to the anterior margin; the position of the eyes in the middle of the cheeks; the narrow free cheeks with the genal angles rounded; the wide thoracic axis, considerably wider than the pleuræ; the strongly marked fulcrum placed very near the axis; the deep pleural grooves; and the rather small tail with entire margin. The number of thoracic segments in the fully developed adult is sixteen, and the axis of the tail shows about five segments.

If the species described below and the *Triarthrus spinosus* of Billings are to be included in the genus, the genal angles need not be rounded and the number of segments in the thorax and tail may be considerably less than in *T. becki*, but the other characters will remain generic.

Peltura is a closely allied form with similar pleuræ, but it has the eyes placed further forwards, the thorax consists of twelve segments, and the tail is serrate.

1. **Triarthrus shinetonensis**, Raw. Plate VII, figs. 13—16.

1908. *Triarthrus shinetonensis*, Raw, Rep. Brit. Assoc. for 1907, p. 512.

Head semi-circular, slightly angulate in front, with the genal angles produced into long spines. Glabella quadrate, a little longer than wide, slightly expanded towards the front, with two pairs of glabellar furrows, both of which are sigmoid and oblique, not quite reaching either the middle line or the axial groove; neck-furrow distinct, but barely reaching the axial groove; neck-segment divided into a large central portion and two antero-lateral lobes, with a median tubercle on the central portion. Eye-lobes long, set rather forward and near to the glabella, with an ocular ridge running towards the glabella. Facial suture probably marginal in front, running backwards from the anterior margin to the eye and from the eye

[1] Excellent figures of this species, in all stages of development, are given by Walcott in Trans. Albany Institute, vol. x (1883), p. 23, pl. ii, figs. 1—15; and reproductions of photographs both of the dorsal and of the ventral surfaces, with the limbs, will be found in a paper by Beecher in Geol. Mag., decade iv, vol. ix (1902), p. 152, pls. ix—xi.

backwards and outwards to the posterior margin, which it cuts just within the genal angle. Fixed cheeks narrow in front, expanding to about two-thirds the width of the glabella behind; frontal limb narrow. Free cheeks very narrow, with the genal angles produced into slender spines which bend a little outwards at their origin and then curve backwards, extending to about the ninth or tenth thoracic segment. Margin consisting of a rather broad and shallow furrow with a narrow raised edge outside it.

Thorax of fourteen segments, the axial rings of the last two fixed to the tail. Axis considerably wider than the pleuræ in front, about equal in width behind, each segment bearing a median tubercle (not visible on internal casts); the twelfth segment provided with a long median spine directed backwards. Pleuræ bent slightly downwards very near to the axis; extremities of the early segments obliquely truncate, of the later segments rounded; pleural grooves deep and broad.

Tail small, rounded, wide in proportion to its length, with a narrow entire margin. Axis forming about one-third of the total width, reaching the posterior margin, divided into two rings and a terminal portion. Lateral lobes with two distinct furrows faintly interlined.

Dimensions.—Length about 20—30 mm.

This is the species named by Mr. Raw *Triarthrus shinetonensis*. He gives no description or figure, but he has very kindly supplied me with a photograph. He informs me also that the segments in front of the twelfth have fairly prominent spines which seem to diminish anteriorly. I have not seen these myself, but in other species have found that tubercles on the axis are often really the bases of spines (see for example *Ctenopyge bisulcata*, p. 82).

The long thoracic spine is not always shown on internal casts, and, as is the case in so many other forms, the tubercles may be indistinct or absent. With regard to the limits of the thorax, in almost every specimen there is a break at the twelfth segment, the thirteenth and fourteenth segments lying, with the tail, at a slightly different level from the rest of the body. The pleuræ of these segments are usually separated from the tail, but the axial rings appear to be united. There is sometimes, however, a distinct trace of an articulating surface between the fourteenth segment and the tail.

Triarthrus shinetonensis is evidently an intermediate form allied on the one hand to *Parabolinella* and on the other to *Triarthrus*. It resembles the former in the general shape of the head, the truncate glabella and the presence of genal spines; it approaches the latter in the narrowness of the frontal limb and of the free cheeks, in the width of the thoracic axis and the shape of the pleuræ. It is not a typical form of either genus, but it appears to be more closely related to *Triarthrus* than to *Parabolinella*.

Nevertheless, the species with which it is most likely to be confounded is

Parabolinella triarthra. A comparison of Plate VII, fig. 7 with Plate VII, fig. 13, will show that there is a striking general resemblance between the two forms. The glabella is almost identical, but in *T. shinetonensis* it extends further forwards, and the first pair of glabellar furrows is obsolete, as is also the case, however, in many specimens of *P. triarthra.* The free cheeks are much narrower in *T. shinetonensis* and the eye-lobe is longer; the genal spines bend slightly outwards at their origin, whereas in *P. triarthra* they continue the line of the cheek-margin.

The thorax is decidedly different. *T. shinetonensis* has fourteen segments, *P. triarthra* when adult has twenty-one; in *T. shinetonensis* a long spine directed horizontally backwards springs from the axis of the twelfth segment. In *T. shinetonensis* the axis of the thorax is relatively wider than in *P. triarthra*, though not quite so wide as in *T. becki;* the pleural grooves are deeper and broader than in *P. triarthra.*

The tail is very similar in the two forms, but in *T. shinetonensis* there are two rings on the axis instead of one, and the grooves on the lateral lobes are stronger.

It is scarcely necessary to enter into any detailed comparison with the other British species of *Parabolinella.* It is at once distinguished from *P. williamsoni* and *P. cæsa* by its small tail, and from *P. rugosa* by the presence of only two pairs of glabellar furrows instead of four.

It differs from the type species of the genus, *Triarthrus becki,* in the presence of genal spines and in the smaller number of segments in the thorax and tail. The glabella, moreover, is less rounded in front and does not reach quite so far forwards, and there is an ocular ridge, which appears to be absent in *T. becki.*

But the form most closely allied to the present species is *Triarthrus spinosus,* Billings.[1] The general shape of the head is nearly the same, and the glabella and free cheeks are similar. In both species the genal angles are produced into slender spines, which bend outwards at their origin, and in both the thoracic axis bears a long median spine. In *T. spinosus,* however, there is in addition, a long spine arising from the neck-segment, and the thoracic spine springs, not from the twelfth, but from the eighth segment. Billings states that he could not find in any specimen more than thirteen segments in the thorax and four or five in the pygidium.

Triarthrus canadensis.—Smith,[2] also has the genal angles spined, but the specimen on which the species is founded is so imperfect that no useful comparison is possible.

Horizon and Locality.—Shineton Shales: Shineton.

[1] Geological Survey of Canada. Report of Progress for the years 1853—56 (1857), p. 340. —Geology of Canada. Geological Survey of Canada. Report of Progress from its Commencement to 1863 (1863), p. 202, fig. 199.

[2] Canadian Journal, new series, vol. vi (1861), p. 275, with woodcut.

Genus **SPHÆROPHTHALMUS**, Angelin.

The genera *Leptoplastus*, *Sphærophthalmus*, *Ctenopyge* and *Eurycare* form a natural group of the Olenidæ, characterised by the fact that the cheek-spines do not spring from the posterior angles of the head, but from the middle of the external margin or even from the anterior lateral angles. In many other forms, even in so typical an *Olenus* as *O. truncatus*, the posterior margin bends towards the front near its outer extremity, so that the genal angles are placed rather forward, but the character is greatly exaggerated in the genera under consideration. In some of the species there is still a definite genal angle although it lies far forward; in others there is no angle at all and the cheek-spine starts abruptly from a perfectly rounded margin.

Brögger considers that all these forms should be placed in a single genus, which he calls *Leptoplastus* and which he divides into four subgenera as follows:[1]

	Head moderately wide, cheek-spines short.	Head generally very wide, cheek-spines very long.
Section I. Pleuræ ending in short points. Tail minute, generally armed with short spines, wide.	*Leptoplastus* (sens. strict.).	*Eurycare*.
Section II. Pleuræ in posterior part of the body geniculate towards their extremities, produced into long reflexed spines. Tail small, entire (or ?), longer.	*Sphærophthalmus*.	*Ctenopyge*.

In formulating this scheme Brögger adopts a somewhat doubtful interpretation of the tail of *Ctenopyge pecten*, which will be discussed later. According to the usual view the tail of that species is neither small nor entire, and its breadth is considerably greater than its length.

Persson's grouping of the same genera has already been given on p. 51. The chief difference in his definitions is that he leaves the tail out of consideration, and that he differentiates *Sphærophthalmus* from *Ctenopyge* by the greater convexity of the glabella and cheeks instead of by the width of the head.

Unfortunately at present no grouping of the species into genera can be more

[1] Die Silur. Etagen 2 und 3, p. 113. Brögger's table is in Latin, which is here freely translated.

than provisional. Most of their remains are very fragmentary. In many species the head alone has been recognised, and in most the tail is quite unknown. It is, moreover, often very difficult to decide whether the pleuræ end in short points or in long spines, for the ends are frequently concealed in the matrix. In many cases it is equally difficult to say whether the margin of the tail was entire or was armed with minute spines.

Of the four genera belonging to this group, *Leptoplastus*, *Sphærophthalmus*, and *Ctenopyge* have all been found in England. *Eurycare* has not yet been definitely recognised, but some imperfect and distorted specimens from Borth and elsewhere may possibly belong to that genus.

The generic characters of *Sphærophthalmus* appear to be as follows:

General form decidedly convex, with strongly marked axial grooves. Head of moderate width; glabella reaching the anterior margin; fixed cheeks rather narrow, convex, very little expanded behind the eyes; eyes placed very far back and near to the glabella; free cheeks with a rounded external margin from the middle of which the cheek-spine springs abruptly.

Thorax of about nine segments, very narrow posteriorly; axis wider than the pleuræ; pleuræ bent downwards at the fulcrum, terminating in points which in the posterior segments are produced into backwardly directed spines.

Tail more or less triangular, with a wide axis and narrow lateral lobes; margin entire.

1. **Sphærophthalmus alatus** (Boeck). Plate VIII, figs. 1—6.

1838. *Trilobites alatus*, Boeck, Keilhau's Gæa Norv., p. 143.
1848. *Olenus humilis*, Phillips, Mem. Geol. Surv., vol. ii, pt. 1, p. 55, figs. 4, 5, 6, p. 347.
1854. ? *Sphærophthalmus alatus*, Angelin, Pal. Scand., p. 49, pl. xxvi, fig. 9.
1854. *Olenus sphænopygus*, Angelin, *op. cit.*, p. 43, pl. xxv, fig. 3.
1854. ? *Anopocare pusillum* (pars), Angelin, *op. cit.*, p. 50, pl. xxvii, figs. 1, 2.
1857. *Sphærophtalmus alatus*, Kjerulf, Geol. d. südl. Norw., p. 284 (*teste* Brögger).
1864. *Olenus* (*Sphærophthalmus*) *humilis*, Salter, Mem. Geol. Surv., Brit. Org. Remains., dec. xi, pt. viii, p. 7, pl. viii, figs. 9—11.
1865. *Sphærophtalmus alatus*, Kjerulf, Veiviser ved geol. excursioner i Christiania omegn., p. 2.
1866. *Olenus* (*Sphærophthalmus*) *humilis*, Salter, Mem. Geol. Surv., vol. iii, p. 302, pl. v, fig. 12.
1871. *Olenus humilis*, Phillips, Geology of Oxford, p. 68, fig. 8.
1880. *Sphærophthalmus alatus*, Linnarsson, Geol. Fören. Stockh. Förh., vol. v, p. 137, pl. v, figs. 6—10.
1882. *Sphærophtalmus alatus*, Brögger, Die Silur. Etagen 2 und 3, p. 119, pl. ii, figs. 14, 14a.
1890. *Sphærophthalmus alatus*, Pompecki, Die Tril.-Fauna preuss. Diluvialgeschiebe. Beitr. zur Naturk. Preussens, vii, p. 89, pl. iv, figs. 27, 27a.
1893. *Sphærophthalmus alatus* var. *canadensis*, G. F. Matthew, Trans. Roy. Soc. Canada, vol. xi, Sect. iv, p. 107, pl. xvii, figs. 11a, b, 12a, b.

Non 1866. *Olenus* (*Sphærophthalmus*) *alatus*, Salter, Mem. Geol. Surv., vol. iii, p. 302, pl. iv, figs. 3, 3a.

Head quadrate, emarginate in front, with rounded sides, from the middle of which the short genal spines spring abruptly. Glabella quadrate, longer than wide, slightly narrowing forwards, truncate in front, just reaching the marginal furrow. Anterior glabellar furrows obsolete, the posterior pair well defined, meeting across the glabella, but rather shallower in the middle than at the sides; neck-furrow strong; neck-segment occasionally showing traces of a median tubercle or spine. Eyes large, round, placed very near to the posterior margin and at a distance from the glabella equal to rather more than half its width; a very oblique ocular ridge visible in some specimens, especially in external casts, but usually absent. Facial suture running in a gently sigmoid curve from the anterior to the posterior margin, its general direction being approximately parallel to the axis. Fixed cheeks narrow, convex, very little expanded behind the eye; free cheeks with the outer border forming a large arc of a circle, margin rather broad and flat. Genal spines short and slender, springing from the middle of the outer margin, bent backwards a short distance from their origin.

Thorax of nine segments, widest about the third segment, much contracted behind. Axis broad, forming more than one-third of the total width, rather convex, with a median tubercle on each segment. Pleuræ short, rapidly decreasing in length posteriorly, with broad oblique grooves, bent downwards at one-third of the way out from the axial furrow; extremities of the first two or three bluntly pointed, of the later segments not clearly seen.

Tail small, triangular, width rather less than twice the length, margin entire. Axis conical, broad, forming the greater part of the tail, consisting of three segments including the terminal portion, ending in a fairly sharp point, not quite reaching the posterior margin, lateral lobes narrow.

Dimensions.—An average cranidium is about 2—2·5 mm. long and 2·2—3 mm. wide; the thorax and tail together about 3·5—5 mm. long, 3—4 mm. wide.

It should be observed that on internal casts the ocular ridges are seldom seen and the median tubercles on the axis of the thorax are often indistinct; but their apparent absence seems to be due merely to the mode of preservation. According to Salter there are only seven thoracic segments; but he seems to have included a part of the thorax with the tail, for he describes the latter as possessing three spines on each side. Probably in his specimens, as is often the case, the hinder end of the body was badly preserved. He also remarks that the free cheeks (so far as he could see) show no trace of the curved spine characteristic of the genus, but evidently he was not quite satisfied on this point. According to Belt[1] the tail is minute and furnished with a long terminal spine; but there is no indication of such a spine in any of the specimens that I have examined.

The specimen shown in Plate VIII, fig. 6, closely resembles Linnarsson's figure

[1] Geol. Mag., vol. v (1868), p. 10.

of the tail of *Sph. majusculus*,[1] but it is, I believe, a tail of *Sph. alatus* with the preceding thoracic segment attached. In many specimens of *Sph. alatus* (see, for example, Plate VIII, fig. 5) the lateral lobes of the tail appear to be almost obsolete, but in such specimens the ends of the thoracic pleuræ are not visible and probably the lateral lobes of the tail are also incomplete. In external casts the axis appears to be relatively wider and the lateral lobes narrower than in Plate VIII, fig. 6, thus approaching more closely to the proportions shown in the figure of the tail of *Sph. alatus* given by Linnarsson.

The only form with which this species is at all likely to be confounded is *Sphærophthalmus major*. The latter, however, is generally larger, and is characterised by a relatively narrower axis and wider side-lobes. In the head the fixed cheeks are nearly as wide as the glabella, while in *S. alatus* they are much narrower. In the tail of *S. major* the lateral lobes form about three-fifths of the total width; in *S. alatus* about one-half; in the former also both the axis and the tail itself are more rounded. The difference in the thorax is not so marked, but even here the axis in *S. majusculus* seems to form a smaller proportion of the total width; the fulcrum, moreover, is rather further from the axial furrows.

Sphærophthalmus alatus is commonly found with various species of *Ctenopyge*, but from all of these it is readily separated. Its general form is more convex. The cranidium is at once distinguished by the backward position of the eye, and the fact that behind the eye the fixed cheek is very little expanded. The free cheek can be recognised by its rounded outer margin, the shortness and slenderness of the cheek-spine, and the round eye set close to the posterior margin. The thorax is characterised by its convexity and the breadth of the axis; and the tail with its wide axis and extremely narrow lateral lobes is quite unlike any other.

The form described by Matthew as *Sphærophthalmus alatus* var. *canadensis* does not appear to differ in any essential features. It has an anterior pair of glabellar furrows, but these are short and seem to be lightly impressed, and their apparent presence or absence may well depend on the state of preservation. There is also an oblique ocular ridge; this is sometimes seen in our English specimens, more especially in external casts. Matthew describes a second variety, which he calls the "narrow form," in which no anterior glabellar furrow and no ocular ridge are visible, but he ascribes to it a free cheek with the eye set rather more forward than in our specimens and with a long and strong genal spine. He himself remarks on the resemblance of this free cheek to one of those referred by Linnarsson to *Ctenopyge*, but concludes from its associations that it really belongs to this species. So far as our English specimens are concerned the evidence is clear that *Sphærophthalmus* had short cheek-spines and *Ctenopyge* long ones.

Synonymy.—According to the strict rules of priority the specific name *alatus* has no right to stand, for Boeck's description is totally inadequate and he supplies no figure, whereas the figure and description given by Phillips are quite unmistak-

[1] Geol. Fören. Stockh. Förh., vol. v (1880), pl. v, fig. 11.

able. Belt[1] in 1868 observed that some fragments of *Sph. alatus* (Boeck) in the British Museum resemble *Sph. humilis* (Phillips), and at a later date Linnarsson, who had examined Boeck's original specimens, stated that there could be no doubt that the two are identical. Since then the name *alatus* has been almost universally used.

Unfortunately Angelin's figure of *Sph. alatus* is quite unlike Boeck's species, and this has led to a considerable amount of confusion. Salter, taking Angelin's figure as his guide, not unnaturally identified it with "*Olenus bisulcatus*." Phillips, now referred to *Ctenopyge*. Consequently in the Survey Memoir on North Wales and in other publications of about that period, *Sph. alatus* usually means *Ctenopyge bisulcata* or some similar form.

Although both the figure and description given by Angelin are so unlike *Sph. alatus*, Linnarsson, judging from the localities mentioned, believes that he really had this species before him, but probably made use of fragments of some other species also. However this may be, there can be no doubt that another of Angelin's species, *Olenus sphænopygus*, is founded on the tail of *Sph. alatus*. According to Linnarsson *Anopocare pusillum*, Ang., is based on the head of *Sph. alatus* and the tail of *Peltura scarabæoides;* but if so, the figures in this case also must be very unlike the specimens.

Horizon and Localities.—Upper Lingula Flags: Malvern; Moel Gron; Rhiwfelyn; Carreg-wen, Borth.

2. **Sphærophthalmus major,** sp. nov. Plate VIII, figs. 7—13.

Head quadrate, wide, with rounded cheeks, from the middle of which the small cheek-spines spring abruptly. Glabella quadrate, slightly narrowing forwards, somewhat rounded in front; anterior glabellar furrows obsolete, posterior pair continuous across the glabella; neck-furrow well defined, probably with a median tubercle or spine. Eyes placed far back, distant from the glabella rather less than the width of the latter; no ocular ridge visible. Facial suture curving backwards and outwards from the anterior margin to the eye, and from the eye backwards and somewhat outwards to the posterior margin. Fixed cheeks at the eye almost as wide as the glabella, slightly expanded behind the eye. Free cheeks rather narrow, the outer margin forming a segment of a circle; from the middle of this margin a slender cheek-spine springs abruptly.

Thorax consisting of nine segments. Axis convex, wide, rather wider than the pleuræ, with a median tubercle on each segment. Pleuræ short, bent downwards about halfway out from the axial furrow, terminating in points which from about the third segment are produced into backwardly directed spines; pleural grooves oblique and rather broad.

[1] Geol. Mag., vol. v (1868), p. 10.

Tail sub-triangular, but with the apex very much rounded, width rather more than twice the length, margin entire. Axis wide, forming about two-fifths of the total width, consisting of three segments, terminating bluntly, not quite reaching the posterior margin. Lateral lobes rather narrow, with a faint furrow near the anterior margin.

Dimensions.—In the specimen figured in Plate VIII, fig. 9, the cranidium is about 3 mm. long and nearly 5 mm. wide at the eyes, the head and thorax together 8 mm. long.

This species is very closely allied to *Sphærophthalmus alatus* and is distinguished chiefly by the relatively narrower axis and wider lateral lobes throughout the body. The head has the fixed cheeks nearly as wide as the glabella, while in *S. alatus* they are little more than half that width. The tail is wider in proportion to its length than in *S. alatus*, but the extra width lies in the lateral lobes; in shape it is more rounded, and the axis also terminates more bluntly. It is in the thorax that the resemblance between the two species is closest; but even here the axis appears to be relatively narrower than in *S. alatus*. Unfortunately in both forms the ends of the pleuræ are usually buried in the matrix and the width cannot be determined. *S. major* is generally larger, and the fulcrum appears to lie somewhat further out than in *S. alatus*.

Sph. majusculus, Linnarsson,[1] bears a considerable resemblance to *Sph. major*. The head which Linnarsson ascribes to that species has the fixed cheeks as wide as the glabella; but the tail, on which the species was founded, is triangular instead of rounded; the axis is more pointed than in *Sph. major*, and consists of four segments instead of three.

Horizon and Localities.—Upper Lingula Flags: Malvern; Moel Gron.

Genus **CTENOPYGE**, Linnarsson.

The genus *Ctenopyge* was founded by Linnarsson[2] for the species *Ctenopyge pecten*, and was separated from *Sphærophthalmus* mainly on account of the characters of the tail. In *Sphærophthalmus* the tail is small, triangular, with an entire margin, and with an axis consisting of only a few segments; in *Ctenopyge* the tail is large, with a multi-articulate axis, and the side-lobes consisting of several segments which are quite distinct from one another and which end in backwardly directed spines. According to Linnarsson the head is similar to that of *Sphærophthalmus*, but with wider fixed cheeks, especially behind the eye; the axis of the thorax is narrower and the pleuræ are produced into reflexed spines.

Unfortunately *Ct. pecten* is the only species of which the tail is known; and in

[1] Geol. Fören. Stockh. Förh., vol. v (1880), p. 141, pl. v, figs. 11, 12.

[2] *Loc. cit.*, vol. v (1880), p. 145.

referring other forms to this genus, Linnarsson based his opinion sometimes on the width of the hinder end of the thorax, sometimes on the width of the fixed cheeks. In retaining Angelin's *Sphærophthalmus flagellifer* in *Sphærophthalmus* he seems to have been guided chiefly by the rapid narrowing of the thorax, for according to the character of the fixed cheeks the species should belong to *Ctenopyge*.

Brögger[1] came to the conclusion that the tail of *Ctenopyge pecten*, as described by Linnarsson, is not the true pygidium in the same sense as the tail of *Sphærophthalmus*. He states that the segments are fused only at the axis and that the pleuræ are free. He looks upon these pleuræ as really a part of the thorax, and suggests that the small terminal portion behind the pleuræ is the true homologue of the tail of *Sphærophthalmus*. He further points out that while heads of *Ct. bisulcata* and of other forms referred to *Ctenopyge* have been found in great abundance, no tails in any way similar to that of *Ct. pecten* have been discovered with them. He concludes that the tails of these species must be small or they could not have been overlooked, and he infers that the large many-spined tail cannot be a generic character, and probably there was no great difference between the tails of *Ctenopyge* and those of *Sphærophthalmus*. He therefore bases his definition of *Ctenopyge* entirely upon the characters of the head and thorax. According to him the head is usually very transverse, with very long cheek-spines; the hinder thoracic pleuræ are geniculate and produced into long reflexed spines. He refers *Sphærophthalmus flagellifer*, Ang., to *Ctenopyge*.

Moberg[2] has attempted to confute Brögger's arguments and concludes that Linnarsson's view is correct. He shows that the tail of *Ct. pecten* is quite distinct from the thorax, but he does not deal with the characters of the tail in the other species referred to the same genus.

Our English specimens confirm Moberg's conclusion. The tail of *Ct. pecten*, as defined by Linnarsson, is certainly not a part of the thorax. It is commonly found detached, and evidently the segments of which it is formed were firmly united to one another. Brögger and Moberg agree that only the axial rings are fused while the pleuræ are free; but this is not what our numerous specimens seem to indicate. The pleuræ seem to be closely connected and rarely show any signs of separation. The small unsegmented plate at the end of the axis is clearly not the homologue of the tail of *Sphærophthalmus*.

But whether this peculiar form of tail occurs in other species is doubtful. The hinder end of the thorax in *Ct. bisulcata* and *Ct. falcifera* is comparatively narrow, and the tail cannot have been very large. The small specimen of *Ct. bisulcata* figured in Plate IX, fig. 4, even seems to indicate that the tail was entire as in *Sphærophthalmus*; but the specimen is too imperfect to admit of any certain conclusions being drawn from it.

[1] Die Silur. Etagen 2 und 3, p. 114.

[2] Geol. Fören. Stockh. Förh., vol. xiv (1892), p. 351.

In any case the available evidence is not sufficient to justify us in assuming that the species with broad fixed cheeks had tails like that of *Ct. pecten*, and if the special character of the genus is to be a tail of this type, the generic position of the greater number of species must remain doubtful. Provisionally, therefore, I adopt Brögger's definition, basing the genus primarily upon the wide fixed cheeks and neglecting the tail. In practice this was also what Linnarsson did in the case of species other than *Ctenopyge pecten*. At the same time it is by no means improbable that when our knowledge of these forms is more extensive it may be found that the large-tailed species really do constitute a distinct group, and if so it is to these that the name *Ctenopyge* should be limited.

The following characters will serve to distinguish the genus from the allied forms. General shape depressed. Head wide, straight or emarginate in front. Glabella nearly parallel-sided or slightly tapering forwards; number of glabellar furrows variable. Eyes large, not so far back as in *Sphærophthalmus*, with an ocular ridge running towards the front of the glabella. Fixed cheeks wide or fairly wide, considerably expanded behind the eye. Free cheeks with a long spine springing abruptly from the middle of the external margin. Thorax usually with nine or ten segments, pleuræ produced into long spines which in the hinder segments are bent strongly backwards.

1. **Ctenopyge fusiformis**, sp. nov. Plate VIII, fig. 14.

Head wide, strongly emarginate in front. Glabella at the neck-furrow forming less than one-third the total width of the cranidium, straight-sided, narrowing considerably forwards, truncate in front, reaching the marginal furrow. Glabellar furrows indistinct or absent, neck-furrow well defined. Eyes placed about half-way between the anterior and posterior margins and at a distance from the glabella rather less than the width of the latter; an oblique ocular ridge running towards the front end of the glabella. Facial suture running obliquely outwards from the anterior margin to the eye, and from the eye obliquely outwards to the posterior margin. Fixed cheeks at the eye rather less than the glabella in width, expanding considerably behind the eye, where the width is about one and a quarter times that of the neck-ring.

Thorax of eight more segments. Axis forming about one-third of the total width, widest about the third segment, with doubtful traces of median tubercles. Pleuræ nearly horizontal and almost straight, but in the first two segments bent slightly downwards and backwards at the extremities, ending, apparently, in short points; pleural grooves broad and deep.

Tail unknown.

Dimensions.—Cranidium 2·8 mm. long, 4·0 mm. wide at the eyes, 6·3 mm. at the posterior margin; thorax (probably incomplete) 4·2 mm. long, 5·8 mm. wide.

In the form of its glabella this species is not unlike *Sphærophthalmus alatus*, and it shows a still more striking resemblance to the cranidium figured by Linnarsson as *Sph. majusculus*; but from both of these species it is distinguished by the wide expansion of the fixed cheeks behind the eyes and by the absence of the strongly marked continuous glabellar furrows.

Of the species of *Ctenopyge* it resembles most closely *Ct. bisulcata* and *Ct. falcifera*. In both of these the axis of the thorax is about equal to the pleuræ in width, as in the present species; but in them it is straight-sided, while in *Ct. fusiformis* it is fusiform. Moreover, in *Ct. bisulcata* and *Ct. falcifera* the pleuræ are produced into long spines, in *Ct. fusiformis* they seem to end in short points—it is, however, possible that these may be longer than they appear in the specimen. In the emarginate front of the cranidium the present species differs from *Ct. bisulcata* and *Ct. falcifera* and resembles *Ct. pecten* and *Ct. teretifrons*, but it differs from them all in the shape of the glabella and the character of the glabellar furrows. Excluding the neck-furrow there are no definite furrows of any kind upon the glabella, but this no doubt is due in part to imperfect preservation. It does not appear possible, however, that the furrows can ever have been strongly marked or that they were continuous across the glabella.

Horizon and Locality.—Upper Lingula Flags: Malvern.

2. **Ctenopyge bisulcata** (Phillips). Plate VIII, figs. 15—19; Plate IX, figs. 1—4.

1848. *Olenus bisulcatus* (pars), Phillips, Mem. Geol. Surv., vol. ii, pt. i, p. 55, fig. 1, p. 346; not fig. 2.

1864. *Olenus bisulcatus* (pars), Salter, Mem. Geol. Surv., Brit. Org. Remains, dec. xi, pt. viii, p. 8; not pl. viii, fig. 6.

1866. ? *Olenus* (*Sphærophthalmus*) *alatus*, Salter, Mem. Geol. Surv., vol. iii, p. 302, pl. iv, fig. 3.

1871. *Olenus bisulcatus*, Phillips, Geology of Oxford, p. 68, fig. 7.

1871. ? *Olenus pauper*, Phillips, *op. cit.*, p. 68, fig. 4.

1880. *Ctenopyge bisulcata*, Linnarsson, Geol. Fören. Stockh. Förh., vol. v, p. 153, pl. v, figs. 18, 19, pl. vi, figs. 1, 2.

Head wide, weakly emarginate in front, with long curved spines springing from the sides of the cheeks. Glabella rather convex, almost parallel-sided, rounded in front. The anterior glabellar furrows obsolete, the posterior pair well marked, meeting across the glabella but rather shallower towards the middle line; neck-furrow strong, but also shallower in the middle than at the sides, neck-segment with a median tubercle. Eyes large, placed a little behind the middle of the cheeks at a distance from the glabella about equal to two-thirds the width of the latter, ocular ridge oblique. Facial suture cutting the anterior margin a little to one side

of the glabella, curving outwards and backwards to the eye and behind the eye bent abruptly outwards and finally backwards to the posterior margin. Fixed cheeks at the eye about two-thirds the width of the glabella, behind the eye expanded to about one and a half times that width. Free cheeks with the outer margin somewhat angulate towards the front; from the angle springs a long strong spine which curves backwards. Hypostome tongue-shaped, parallel-sided, with an oval convexity in the proximal portion.

Thorax consisting of ten segments, rapidly decreasing in width from the fifth segment. Axis rather less than the pleuræ in width, with straight sides, narrowing posteriorly, each segment bearing a median tubercle or spine; the axis of the tenth segment somewhat triangular, produced into a long straight spine directed backwards. Pleuræ straight and horizontal nearly to their extremities, where they are bent slightly downwards, rapidly decreasing in length after the fifth segment, extremities produced into long spines, which in the first three or four segments are directed outwards and only slightly backwards, but in the later segments are progressively more and more strongly bent backwards; pleural grooves broad and deep, especially near the outward end, terminating at the commencement of the spines.

Tail very imperfectly known, apparently rather small, triangular. Axis wide, forming almost half the total width, lateral lobes narrow.

Dimensions.—The cranidium varies from about 2·5 mm. to 5 mm. in length and from 6 mm. to 12 mm. in width at the posterior margin. The thorax shown in Plate IX, fig. 1, must have been rather less than 10 mm. long when complete, and that shown in Plate IX, fig. 2, rather less than 7 mm. These appear to be fairly average examples of the long and the broad forms when fully grown.

The tubercles on the axis of the thorax are not always clear, especially on internal casts. They appear to have been the bases of short spines, for in external moulds the corresponding depressions penetrate some depth into the matrix, and the solitary thoracic segment figured in Plate IX, fig. 3, shows a definite spine rising from the axis.

In Plate IX, fig. 1 it will be seen that two spines appear to spring from the axis of the tenth segment, one straight and the other curved. Such an arrangement looks abnormal, and it is natural to suspect that one of these spines may be a fragment of some other individual accidentally brought into its present position. A close examination with the microscope proves, however, that both spines are definitely connected with the axis. The specimen shows the interior of the test, and in the normal position the curved spine would be beneath the straight one. The straight spine was probably a sheath in which the other usually lay.

There appear to be both a long form (Plate IX, fig. 1) and a broad form (Plate IX, fig. 2) of this species, and in the former the thoracic spines are much

more definitely geniculate than in the latter. It is possible that they may be two distinct species, but the material available is hardly sufficient to determine the point, and as many other trilobites show similar variations in relative length and breadth, it is probable that the difference is not specific.

The species which is most closely allied to *Ct. bisulcata* is *Ct. falcifera*, but there are several important differences which appear to be characteristic. The glabella in *Ct. bisulcata* is nearly parallel-sided and the posterior glabellar furrows are continuous across; in *Ct. falcifera* on the other hand the glabella narrows a little forwards, and the posterior glabellar furrows are very oblique and do not meet in the middle line. The eye in *Ct. bisulcata* is placed nearer to the posterior margin and closer to the glabella than in *Ct. falcifera*, and accordingly the ocular ridge is more oblique and the fixed cheek narrower in the former species. The axis of the thorax is relatively a little wider in *Ct. bisulcata* and the thorax begins to narrow rapidly about the fifth segment, while in *Ct. falcifera* it preserves almost the same width up to the eighth segment. The pleural spines are considerably longer and rather more slender in *Ct. bisulcata* than in *Ct. falcifera*.

So far as the thorax is concerned there is no danger of confounding *Ct. bisulcata* with either *Ct. pecten* or *Ct. expansa*, for in both of these the axis is very much narrower than the pleuræ, while in *Ct. bisulcata* it is about the same width. The free cheeks of *Ct. bisulcata* and *Ct. pecten* are also easily distinguished—in the former the genal spine makes a large angle with the external margin, in the latter a very small angle. It is not always, however, by any means easy to distinguish the cranidia. The front margin in *Ct. bisulcata* is almost straight, in *Ct. pecten* it is emarginate. The eye in *Ct. bisulcata* is placed rather further back and nearer to the glabella than in *Ct. pecten* and the ocular ridge is accordingly more oblique. In *Ct. pecten*, moreover, the facial suture runs from the eye in a straight oblique line to the posterior margin; in *Ct. bisulcata* it at first runs almost parallel to the margin and then curves backwards. But there are many specimens of cranidia in which these characters are not clearly distinguishable.

The thorax of *Ct. bisulcata* closely resembles the thorax of *Sphærophthalmus flagellifer* as figured and described by Linnarsson.[1] It differs, however, in the very much greater length of the pleural spines. Moreover, according to Linnarsson it is the axis of the eighth segment in *Sph. flagellifer* which bears a long spine. In his fig. 17, however, the spine appears to spring from the ninth segment, and in Brögger's[2] figure of the same species the eighth segment shows no indication of a median spine, while the ninth is broken.

Synonymy.—It is, unfortunately, impossible to identify the actual specimens upon which Phillips founded the species; but from the form of the glabella, the

[1] Geol. Fören. Stock. Förh., vol. v (1880), p. 142, pl. v, figs. 15—17.

[2] Die Silur. Etagen 2 und 3, pl. ii, fig. 16.

obliquity of the ocular ridge and the course of the facial suture, I suspect that only his fig. 1 belongs to this species and that fig. 2 is a cranidium of *Ct. pecten*.

Salter came to the conclusion that *Ct. bisulcata* was identical with the Scandinavian species *Sphærophthalmus alatus*, but he was misled by Angelin's figure, which is totally unlike that form. His own figure is very different from that of Phillips, but it may possibly represent a very imperfect specimen of the species.

Belt,[1] after examining the original specimens, concluded that Phillips's *Olenus bisulcatus* and Salter's *Olenus pecten*, *Olenus flagellifer* and *Olenus alatus* all belong to one and the same species, but are not identical with Boeck's *Sphærophthalmus alatus*. According to him both *Sphærophthalmus* (*Ctenopyge*) *bisulcatus* and *Sph. humilis* (*Sph. alatus*) have a minute pygidium with a long terminal spine, and in the case of *Sph. bisulcatus* the margin is serrated.

Horizon and Localities.—Upper Lingula Flags: Malvern; Moel Gron.

3. **Ctenopyge falcifera**, sp. nov. Plate IX, figs. 5, 6.

Head quadrate, with the anterior lateral angles produced into spines. Glabella rather less than twice as long as it is wide, narrowing very slightly forwards, rounded in front, reaching the marginal furrow; one pair of glabellar furrows, decidedly oblique, not meeting in the middle line; neck-furrow shallow towards the middle, well-defined laterally; neck-segment with a median tubercle. Eyes large, placed nearly in the middle of the cheek, at a distance from the glabella about equal to the width of the latter; ocular ridge long and oblique. Facial suture cutting the anterior margin very obliquely, curving backwards to the eye, bending abruptly outwards behind the eye and finally backwards to the posterior margin, which it meets at a distance from the axial furrow about equal to one and a half times the width of the glabella at its base. Fixed cheeks in front of the eye about equal in width to the glabella, expanding behind the eye to one and a half times that width; free cheeks somewhat quadrate, marginate, the margin produced into a distinct tongue in front of the fixed cheek, rather convex, with a flattened area at the anterior external angle, this angle produced into a long slender spine at first directed outwards and slightly forwards, but very soon bent backwards, extending at least as far back as the posterior end of the thorax. Hypostome tongue-shaped, but abruptly narrowed near the distal extremity, an oval convex elevation forming the central part of the quadrate proximal portion.

Thorax of nine or more segments, almost uniform in width up to the eighth segment. Axis rather less than the pleuræ in width, with a median tubercle on each segment. Pleuræ straight, horizontal except close to their extremities, which in

[1] Geol. Mag., vol. v (1868), p. 10.

the first four or five segments are bent slightly downwards, rather broad (in the direction of the axis), obliquely grooved; extremities produced into strong curved spines, which in the anterior segments are more than half the length of the pleuræ and in the later segments become progressively longer and more curved backwards.

Dimensions.—Head and thorax about 12 mm. long.

This form closely resembles *Ct. bisulcata* but differs in several minor characters. The eye is placed more forwards and further away from the glabella, and accordingly the ocular ridge is more nearly at right angles to the axis, and the fixed cheeks at the eye are wider. The glabellar furrows are decidedly oblique and are not continuous across the middle line as they are in *Ct. bisulcata*, but in cleaved rocks it is often difficult to determine whether there was original continuity or not. The free cheeks are more distinctly angulate than in *Ct. bisulcata*, the cheek-spine springs from a more forward point and at its origin is directed forwards. The thorax is more uniform in width; in *Ct. bisulcata* it begins to decrease rapidly about the fifth segment, in *Ct. falcifera* not until the eighth. The axis is rather narrower in the latter species, and the pleural spines are shorter and more falcate in shape. The tenth segment is only shown imperfectly in our specimens, but the axial ring is somewhat triangular and probably bore a median spine as in *Ct. bisulcata*.

The thorax and free cheeks are quite unlike those of *Ct. pecten*; but the cranidia of the two species are not markedly different. In *Ct. pecten*, however, the anterior margin is more strongly emarginate, in *Ct. falcifera* it is nearly straight. In *Ct. pecten* the eye appears to be larger, extending as far forwards as in *Ct. falcifera*, but also reaching further backwards. The posterior branch of the facial suture in *Ct. falcifera* runs outwards from the eye and then curves back, meeting the posterior margin at a considerable angle; in *Ct. pecten* it seems to run almost in a straight line outwards and slightly backwards, meeting the posterior margin at a very acute angle.

The wider fixed cheeks of *Ct. directa* and *Ct. teretifrons* serve at once to distinguish those forms; and the narrower thoracic axis and wider pleuræ separate *Ct. expansa* from the present species.

Horizon and Localities.—Upper Lingula Flags: Malvern; Rhiwfelyn.

4. **Ctenopyge pecten** (Salter). Plate IX, figs. 7—9; Plate X, figs. 1—7.

1848. *Olenus bisulcatus* (pars), Phillips, Mem. Geol. Surv., vol. ii, pt. i, p. 55, fig. 2.

1864. *Olenus* (*Sphærophthalmus*) *pecten*, Salter, Mem. Geol. Surv., Brit. Org. Rem., dec. xi, pt. viii, p. 9, pl. viii, fig. 12; not fig. 13.

1864. *Olenus bisulcatus* (pars), Salter, *loc. cit.*, pl. viii, fig. 6.

1865. *Olenus (Sphærophthalmus) pecten*, Salter, Quart. Journ. Geol. Soc., vol. xxi, p. 481, figs. 4, 5.
1873. *Olenus (Sphærophthalmus) pecten*, Salter, Cat. Camb. Sil. Foss. Mus. Cambridge, p. 12, fig.
1880. *Ctenopyge pecten*, Linnarsson, Geol. Fören. Stockh. Förh., vol. v, p. 146, pl. vi, figs. 5—7, ? 9; not figs. 3, 4, 8.
1892. *Ctenopyge pecten*, Moberg, Geol. Fören. Stockh. Förh., vol. xiv, p. 351, figs. 1, 2.

Head wide, emarginate in front, with genal spines springing from the middle of the free cheeks. Glabella rather narrow, narrowing anteriorly, rounded in front, reaching the marginal furrow, the anterior pair of glabellar furrows obsolete, the posterior pair decidedly oblique, meeting across the middle; neck-furrow well defined, with a median tubercle. Eyes large, oval, long axis inclined forwards and outwards, placed near the middle of the cheeks; ocular ridge oblique. Facial suture cutting the anterior margin very obliquely, running backwards and outwards to the eye, and behind the eye bent abruptly outwards and backwards in a straight line to the posterior margin, which it meets at an acute angle. Fixed cheeks at the eye about equal in width to the glabella, behind the eye nearly twice that width; Free cheeks with a convex outer margin and a nearly straight posterior margin meeting at a definite angle. Genal spines proceeding not from the genal angle but from a point some distance above, directed outwards and backwards, the outer edge being almost continuous with the outer edge of the cheek.

Thorax consisting of eight or nine segments, considerably wider than the head, attaining its greatest width about the fifth segment. Axis very narrow, less than one sixth of the total width, each segment with a median tubercle. Pleuræ long and slender, straight, horizontal, terminating in slender spines; pleural grooves narrow, running nearer to the anterior than to the posterior border, continued into the base of the spines.

Tail apparently consisting of six segments, similar to those of the thorax, fused to a smaller terminal portion; width about one and a half times the length. Axis very narrow, about a quarter of the total width, with a ridge down the middle which finally becomes free and is continued as a long straight spine directed horizontally backwards; the axis on each side of the ridge divided by six oblique furrows. Lateral lobes showing six distinct pleuræ fused together and retaining all the characters of those of the thorax, each pleura ending in a long spine directed backwards and sometimes inwards. Behind the last pleura is a small terminal plate, emarginate behind.

Dimensions.—The most complete specimen available (Plate IX, fig. 9) appears to have had a length of about 9 mm. and a width of about 10 mm.; and this seems to have been rather below the usual size. Plate X, fig. 4 shows a part of a considerably larger individual, and fragments of still larger ones are to be seen in the Oxford University Museum.

The thorax and tail can scarcely be confounded with those of any other

recognised species of the genus. No other tail of the same type is known, while in the thorax the very narrow axis and wide pleural lobes are alone sufficient to distinguish it from the majority of the other forms. Only *Ct. expansa* approaches it in these respects. In that species the axis is even narrower in proportion to the pleuræ, and the pleuræ are specially characterised by thread-like ridges along the anterior and posterior borders, and by the position of the pleural groove.

The free cheek also is quite unmistakable. In *Sphærophthalmus* and *Ctenopyge* generally the cheek-spine springs from the middle of the external margin; but in the other species the spine at its origin is nearly at right angles to the margin, while in *Ct. pecten* it makes so small an angle that the outer edge of the spine is almost the direct continuation of the outer edge of the cheek.

But the cranidium by itself is not very easy to recognise. It is usually more strongly emarginate than in *Ct. bisulcata*, *Ct. falcifera* and *Ct. directa;* but as shown in Plate IX, fig. 7, this character is not always very clearly seen. The fixed cheek at the eye is about equal in width to the glabella, as in *Ct. falcifera*, while in *Ct. directa* and *Ct. teretifrons* it is wider and in *Ct. bisulcata* it is narrower. The ocular ridge makes about the same angle with the axis as in *Ct. falcifera*, in *Ct. bisulcata* the angle is smaller, and in *Ct. directa* and *Ct. teretifrons* it is larger. The eye appears to be longer than in other species, so that although the front is well forwards the back is as near to the posterior margin as in *Ct. bisulcata*. The facial suture cuts the anterior margin nearer to the glabella than in *Ct. bisulcata;* behind the eye it turns almost parallel to the posterior margin, meeting the latter at a very acute angle; in *Ct. bisulcata* and *Ct. falcifera* it bends back near its extremity so as to make a considerable angle with the margin, while both in *Ct. directa* and *Ct. teretifrons* its course behind the eye is much more oblique, more backwards and less outwards.

Horizon and Localities.—Upper Lingula Flags: Malvern.

5. **Ctenopyge expansa** (Salter). Plate X, fig. 8.

1873. *Olenus expansus*, Salter, Cat. Camb. Sil. Foss. Mus. Cambridge, p. 12.
1900. *Olenus* (*Ctenopyge*?) *expansus*, F. R. C. Reed, Geol. Mag. [4], vol. vii, p. 306, pl. xii, figs. 2, 3.

Of this species only the thorax is known with certainty, but the specimens may possibly include a part of the tail. Salter's types have been described and figured by Mr. Reed.

In the best specimen portions of ten segments are visible, but it is not clear how much belongs to the thorax and how much to the tail. The axis is narrow, less than one-third the width of the pleuræ, almost parallel-sided, with very faint indications of median tubercles. The pleuræ are flat, with a thread-like ridge near the anterior border and another very close to the posterior border; the pleural groove

is very narrow, running close to the anterior ridge, becoming somewhat broader towards its extremity, where it bends back and is continued into the point; the pleuræ end in short re-curved points.

The very narrow axis and wide pleuræ at once distinguish this species from any other except *Ct. pecten*. In that species the pleuræ are more slender and there is no indication of the raised ridges along the borders.

The species is referred by Salter to *Olenus* (*Sphærophthalmus*) and by Reed to *Olenus* (*Ctenopyge ?*). Mr. Reed remarks that "it is extremely doubtful to what subgenus or even genus this imperfect fossil should be ascribed. It however seems more allied to *Eurycare* or *Ctenopyge* than to *Sphærophthalmus*." In spite of the peculiarity of the pleuræ, they are certainly more like those of *Ct. pecten* than those of any other trilobite with which I am acquainted, and I agree, therefore, with Mr. Reed in referring the species to *Ctenopyge*.

Horizon and Locality.—Upper Lingula Flags: Moel Gron.

6. **Ctenopyge teretifrons** (Angelin). Plate X, figs. 9, 10.

1854. *Sphærophthalmus teretifrons*, Angelin, Pal. Scand., p. 49, pl. xxvi, fig. 10.
1880. *Ctenopyge teretifrons*, Linnarsson, Geol. Fören. Stock. Förh., vol. v, p. 152, pl. vi, figs. 12, 13.

Head very strongly emarginate in front. Glabella narrow, long, reaching the marginal furrow, the front portion somewhat expanded, swollen and rounded. One pair of glabellar furrows, oblique, probably meeting across the middle line, but there very shallow; neck-furrow also shallow towards the middle, neck-segment with a median tubercle. Eyes placed rather far forwards and at a distance from the glabella almost twice the width of the latter; ocular ridge almost at right angles to the axis. Facial suture cutting the anterior margin considerably to one side of the glabella, running in nearly a straight line from the anterior margin backwards and outwards to the eye, behind the eye curving backwards and only slightly outwards to the posterior margin. Fixed cheeks at the eye almost twice the width of the glabella, somewhat convex, not much expanded behind the eye; posterior margin sigmoid, curving forwards towards its outer extremity.

Dimensions.—Cranidium about 2 mm. long in the axial line, 5·4 mm. wide at the posterior margin (measurements taken from the uncompressed specimen, Plate X, fig. 10).

Although the specimens here described are far from perfect, their resemblance to Angelin's type as figured by Linnarsson is so close that there can be little doubt that they belong to the same species. The ocular ridge does not show quite the same curvature, and the small tubercle on the front lobe of the glabella is not visible

PLATE VII.

FIGS. PAGE.

Parabolinella williamsoni (Belt). 64

1. Enlargement of the tail of the specimen figured in Plate. VI, fig. 12, showing the conical termination of the axis. Upper Lingula Flags, Moel Gron. Sedgwick Museum. × 1½.

Parabolinella cæsa, sp. nov. 66

2. The only specimen known. Upper Lingula Flags, Dolgelly. British Museum, I. 722. Presented by Dr. Hicks. × 1½.

Parabolinella rugosa, Brögger, var. 67

3. Cranidium. The somewhat tuberculate appearance seems to be due to little crystals of iron-pyrites which have been oxidised. Tremadoc Slates, Naut-y-Glasdwr near Carmarthen. Sedgwick Museum. (Figured by Misses Crosfield and Skeat, Quart. Journ. Geol. Soc., vol. lii, pl. xxvi, fig. 11.) × 1½.

Parabolinella triarthra (Callaway). 68

4. A large specimen. Shineton Shales, Shineton Brook, near Cressage. British Museum, I. 7533. Nat. size.
5. A specimen of average size: the twenty-first thoracic segment appears to be present, but is not very clear. Shineton Shales, Shineton. Sedgwick Museum. × 1½.
6. Another specimen, with twenty-one thoracic segments. Shineton Shales, Shineton. Sedgwick Museum. × 1½.
7. Specimen with free cheeks attached. Shineton Shales, Shineton. Sedgwick Museum. Presented by Dr. T. Groom. × 1½.
8. A large cranidium. Shineton Shales, Belswardine Brook, near Shineton. British Museum, I. 14562. (The counterpart of this specimen is in the Sedgwick Museum.) × 1½.
9. Impression of a smaller cranidium, showing the glabellar furrows very perfectly; the surface is distinctly punctate. Shineton Shales, Shineton. Sedgwick Museum. Presented by Dr. T. Groom. × 1½.
10. Probably a young form. Shineton Shales, Shineton. Sedgwick Museum. Presented by Dr. T. Groom. × 1½.
11. Cranidium similar to that of fig. 10. Shineton Shales, Shineton. Presented by Dr. T. Groom. × 1½.
12. Young form, probably of this species, with about eight thoracic segments. Shineton Shales, Shineton. Sedgwick Museum. Presented by Dr. T. Groom. × 6.

Triarthrus shinetonensis, Raw. 70

13. A nearly perfect specimen of thorax and head with free cheeks attached. Shineton Shales, Shineton. Sedgwick Museum. × 2.
14. External cast, showing the impressions of the median tubercles or spines. Shineton Shales, Shineton. Sedgwick Museum. × 2.
15. Thorax and tail, with parts of free cheeks, and hypostome. Shineton Shales, Shineton. Sedgwick Museum. × 2.
16. Tail and part of thorax. Shineton Shales, Shineton. Sedgwick Museum. × 2.

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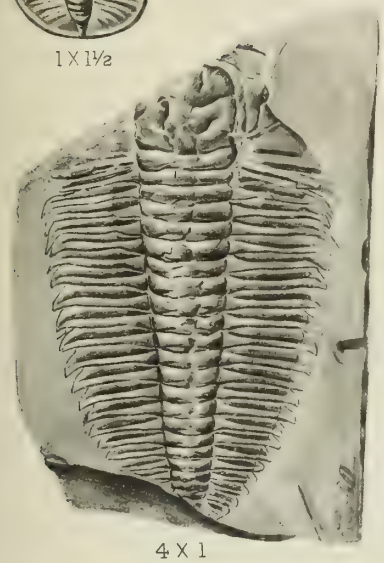

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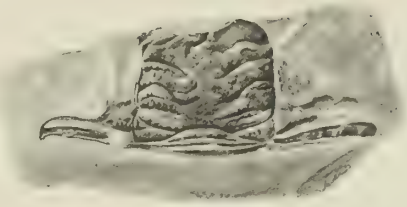

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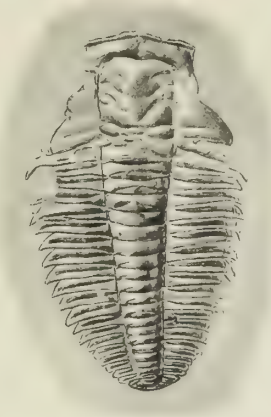

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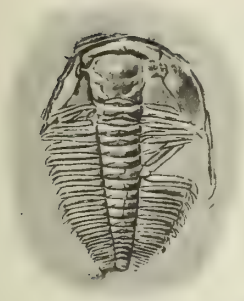

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11 X 1½

10 X 1½

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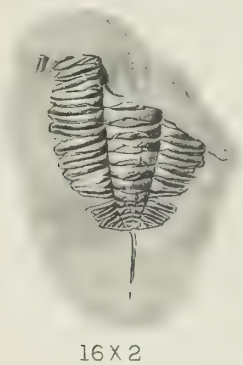
14 X 2

15 X 2



16 X 2

PARABOLINELLA, TRIARTHRUS.

PLATE VIII.

FIGS. PAGE.

Sphærophthalmus alatus (Boeck). 74

1. Cranidium with neck-spine. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8906. × 4.
2. External cast of cranidium with ocular ridges. Upper Lingula Flags, White-leaved Oak, Malvern. Museum of Practical Geology, 26067. × 4.
3. Free cheek. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.
4. Cranidium and thorax. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.
5. Thorax and tail. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8913. × 4.
6. Tail, with the last thoracic segment attached. Upper Lingula Flags, White-leaved Oak, Malvern. British Museum, I. 14843. Presented by Mr. J. E. Lee. (The horizon is given as Lower Lingula Flags.) × 4.

Sphærophthalmus major, sp. nov. 77

7. Cranidium. Upper Lingula Flags, White-leaved Oak, Malvern. Museum of Practical Geology, 8903. × 4.
8. Free cheeks in their proper relative position, with part of thorax. Upper Lingula Flags, White-leaved Oak, Malvern. British Museum, I. 14851. G. H. Piper Collection. × 4.
9. Head and thorax. Upper Dolgelly Beds. British Museum, I. 7619. Belt Collection. × 4.
10. Thorax and tail. Upper Lingula Flags, White-leaved Oak, Malvern. British Museum, I. 14849. G. H. Piper Collection. × 4.
11. Thorax and tail. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.
12. Imperfect head and thorax, showing pleural spines. Upper Lingula Flags, Malvern. Oxford University Museum. × 4.
13. Imperfect head and thorax, showing pleural spines. Upper Lingula Flags, Malvern. Oxford University Museum. × 4.

Ctenopyge fusiformis, sp. nov. 80

14. Cranidium and thorax. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.

Ctenopyge bisulcata (Phillips). 81

15. Cranidium of average size. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.
16. Small cranidium with spine. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8886. × 4
17. Free cheek. Upper Lingula Flags, White-leaved Oak, Malvern. Museum of Practical Geology, 26068. × 4.
18. Hypostome. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8990. × 6.
19. Small cranidium and thorax. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.

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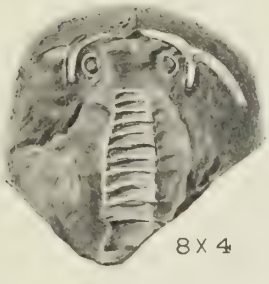

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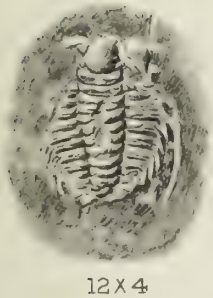

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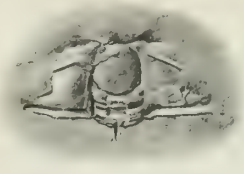

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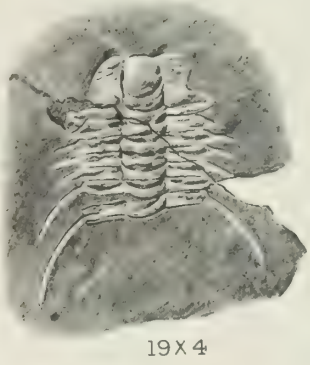

19 X 4

SPHÆROPHTHALMUS, CTENOPYGE.

PLATE IX.

FIGS. PAGE.

Ctenopyge bisulcata (Phillips). 81

1. Thorax, long form. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8884. × 4.
2. Thorax, broad form. Upper Lingula Flags, White-leaved Oak, Malvern. Museum of Practical Geology, 8940. × 4.
3. Thoracic segment, showing median spine. Upper Lingula Flags, White-leaved Oak, Malvern. British Museum, I. 14850. G. H. Piper Collection. × 4.
4. Small thorax with tail, very imperfect. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.

Ctenopyge falcifera, sp. nov. 84

5. Head and thorax. The right free cheek appears to be nearly in its natural position, the left one is pushed partly over the fixed cheek. Upper Lingula Flags, Rhiwfelyn. Sedgwick Museum. Presented by Mr. D. Homfray. × 4.
6. Hypostome. Upon the same slab of rock as fig. 5. × 6.

Ctenopyge pecten (Salter). 85

7. Cranidium and thorax. Upper Lingula Flags, White-leaved Oak, Malvern. British Museum, I. 14844. Presented by Mr. J. E. Lee. (The horizon is given as Lower Lingula Flags.) × 4.
8. Head and thorax. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8916. × 4.
9. Part of head, thorax and tail (external cast). Upper Lingula Flags, Malvern. Museum of Practical Geology, 8914. × 4.

Lake, Cambrian Trilobites. PLATE IX

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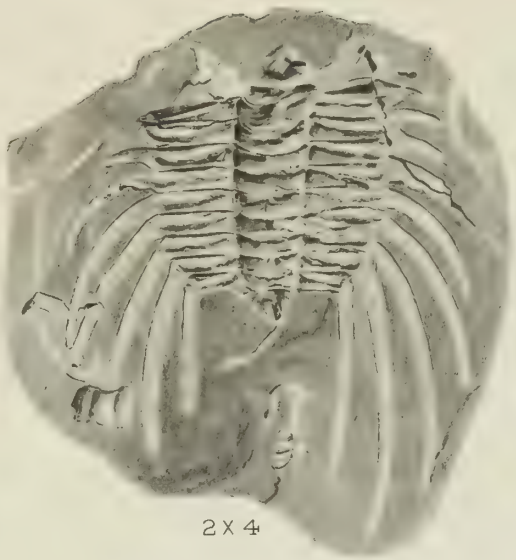

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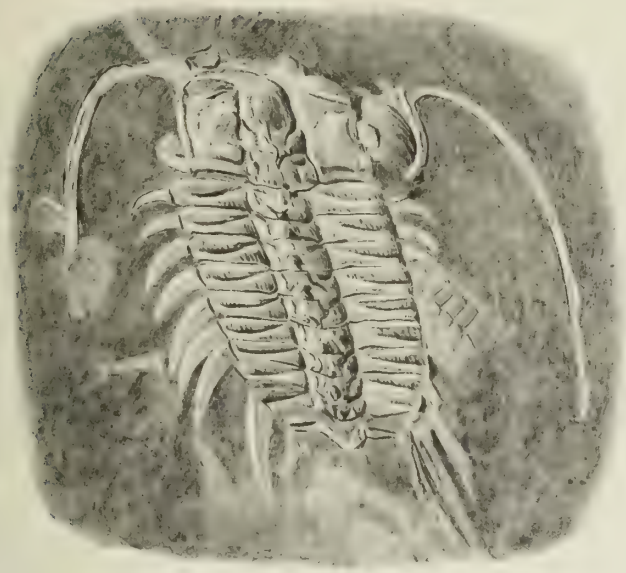

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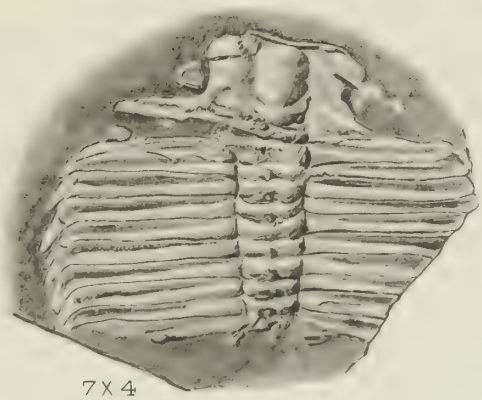

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CTENOPYGE.

A. Brock, del. London Stereoscopic Co. Im

PLATE X.

FIGS. PAGE.

Ctenopyge pecten (Salter). 85

1. Cranidium. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8912. × 4.
2. Free cheek. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.
3. Free cheek. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8986. × 4.
4. Part of thorax. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8915. × 4.
5. Impression of tail. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.
6. Tail, showing the terminal plate. Upper Lingula Flags, Malvern. Museum of Practical Geology, 8981. × 4.
7. Tail. Upper Lingula Flags, Malvern. British Museum, I. 14846. Dr. Holl's Collection. × 4.

Ctenopyge expansa (Salter). 87

8. Thorax. Upper Lingula Flags, Moel Gron. Sedgwick Museum. Presented by Mr. J. Plant. (Figured by Mr. F. R. C. Reed, Geol. Mag., 1900, pl. xii, fig. 3. The counterpart of this specimen is in the British Museum, 59293.) × 4.

Ctenopyge teretifrons (Angelin). 88

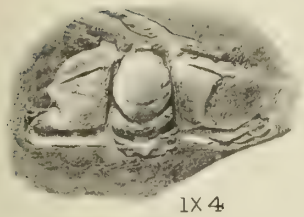
9. Cranidium, laterally compressed. Upper Lingula Flags, Moel Gron. Sedgwick Museum. × 4.
10. Cranidium. Upper Lingula Flags, Malvern. Oxford University Museum. × 4.

Ctenopyge directa, sp. nov. 89

11. Cranidium. Upper Lingula Flags, Malvern. Sedgwick Museum. × 4.

Lake, Cambrian Trilobites.

PLATE X



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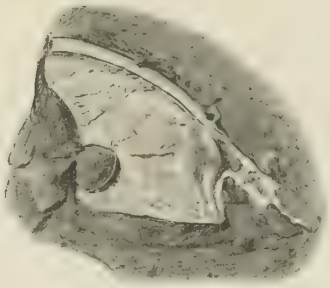

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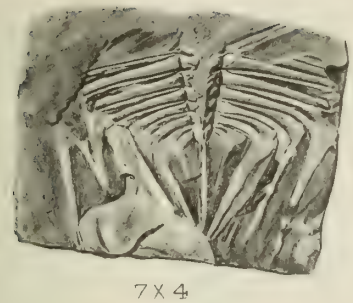

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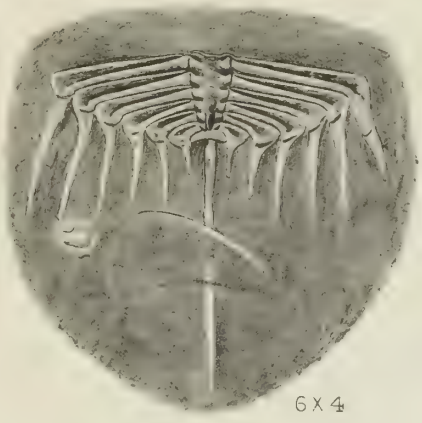

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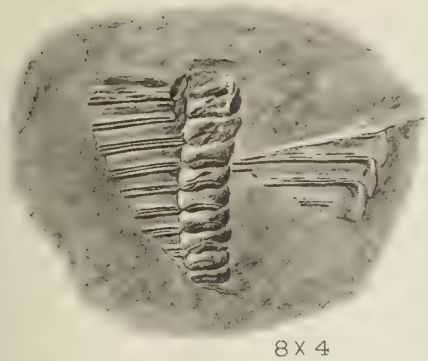

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Palæontographical Society, 1912.

A MONOGRAPH

OF THE

CRETACEOUS LAMELLIBRANCHIA

OF

ENGLAND.

BY

HENRY WOODS, M.A.

UNIVERSITY LECTURER IN PALÆOZOOLOGY, CAMBRIDGE.

VOL. II. PART IX.

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Family—OSTREIDÆ, *Lamarck.*

[Omitted from Vol. I, p. 223.]

The great difficulties in the systematic study of the Ostreidæ have been felt by nearly all writers,[1] and are due mainly to the extraordinary variation in the form of the shell. This variation has been brought about by changes in the physical conditions of habitat, and particularly by differences in the character of the surface to which the left valve is fixed; it is found that the mode of growth and ultimate shape of the shell are determined mainly by the size, shape, and position of the attached surface, so that commonly any one species shows an amazing variety of forms which can, however, be linked together by large series of specimens. A further difficulty in the systematic study of oysters is due to the fact that the shell usually possesses little or no ornamentation.

Various generic or sub-generic divisions have been proposed for the Ostreidæ, *e. g. Ostrea*, *Lopha* (= *Alectryonia*), *Arctostrea*, *Exogyra*, *Amphidonta*, *Gryphæa*, *Pycnodonta*, *Gryphæostrea;* but it appears to me that the phylogenetic relationship of the species of oysters is more complex than is represented by these divisions, and that a natural grouping can only be established when more is known of the evolution of the species. The forms with radial folds have usually been grouped together under the name *Alectryonia;* but there can be no doubt that such folds have originated independently in more than one line of descent, and their presence does not necessarily indicate close relationship. Thus, for example, *Ostrea semiplana*, which has been commonly referred to *Alectryonia*, appears to be more closely allied to *Ostrea vesicularis* than to any species of *Alectryonia*. The Cretaceous forms which have been referred to *Gryphæa* clearly owe their grypheate character to the small size of the attached surface,[2] and can be traced into forms having the characters of *Ostrea*. In studying the Upper Cretaceous oysters of Tunis, Peron[3] has already noticed that some individuals of a species may present the characters of *Ostrea*, whilst others are exogyriform or grypheate. In the Chalk of England *Ostrea semiplana* is usually ostreiform, but occasionally, when the attached surface is behind the umbo, the shell is at first exogyriform, but afterwards becomes ostreiform.

[1] See, for example, the remarks of Hill and Vaughan, "Lower Cretaceous Gryphæas of the Texas Region" ('Bull. U.S. Geol. Survey,' No. 151, 1898), p. 24; and Peron, "Descript. Brach., etc, Terr. Crét. Tunisie" (1890—91), pp. 105—109.

[2] See R. T. Jackson, "Phylogeny of the Pelecypoda. The Aviculidæ and their Allies" ('Mem. Boston Soc. Nat. Hist.,' vol. iv, 1890), p. 317; H. Douvillé, 'Bull. Soc. géol. France,' ser. 4, vol. x (1910), pp. 635, 642.

[3] Op cit., p. 107.

In this work *Exogyra* is retained as a genus since the species dealt with seem to be genetically related, but it is probable that the exogyriform type has originated independently in some earlier deposits. It is even possible that a few species referred to *Ostrea* may have arisen from an exogyriform type by the increase in the size of the attached surface, and the gradual loss of the spiral character of the umbo.

In the Ostreidæ, perhaps even more than in the case of *Inoceramus*, the number of figures which can be given is altogether insufficient to convey an adequate idea of the great variability of the species. It is only by the study of very extensive collections of specimens that one can hope to arrive at satisfactory conclusions.

Genus—Ostrea, *Linnæus*, 1758.

('Syst. Nat.,' ed. 10, p. 696.)

Ostrea diluviana, *L.* Text-figures 98–138.

1767. Ostrea diluviana, *Linnæus*. Syst. Nat., ed. 12, p. 1148.
1768. *G. W. Knorr and J. E. M. Walch.* Recueil. Mon. Catastr. Pétrificat., vol. ii, p. 123, pl. D ii, figs. 5, 6.
1779. "Gryphite," *B. Faujas-St.-Fond.* Hist. nat. Mont. St. Pierre de Maestricht, p. 151, pl. xxiv, figs. 1, 2.
1806. Ostrea pectinata, *Lamarck.* Ann. du Muséum, vol. viii, p. 165; vol. xiv, 1809, pl. xxiii, f. 1.
— — carinata, *Lamarck.* Ibid., vol. viii, p. 166.
1811. — frons, *J. Parkinson.* Organic Remains, vol. iii, p. 217, pl. xv, fig. 4.
1813. Ostracites plicatissimus, *E. T. v. Schlotheim.* In Leonhard's Taschenb. für Min., vol. vii, p. 112.
1819. Ostrea colubrina, *Lamarck.* Anim. sans Vert., vol. vi, p. 216 (*non* Goldfuss).
— — carinata, *Lamarck.* Ibid., p. 216.
— — diluviana, *Lamarck.* Ibid., p. 214.
1821. Ostracites diluvianus, *G. Wahlenberg.* Petrific. Tellur. Suecanæ, p. 58.
1822. Ostrea carinata, *J. Sowerby.* Min. Conch., vol. iv, p. 89, pl. cccIxv.
— — — *G. B. Sowerby.* Genera Recent and Foss. Shells, No. vi, fig. 1.
— — serrata, *G. Cuvier and A. Brongniart.* In Cuvier's Ossemens Foss., vol. ii, pt. 2, pp. 251, 599, pl. iii, fig. 10.
— — carinata, *Cuvier and Brongniart.* Ibid., pp. 320, 599, pl. iii, fig. 11.
1824. — macroptera, *J. de C. Sowerby.* Min. Conch., vol. v, p. 105, pl. cccclxviii, figs. 2, 3.

1827. Ostrea diluviana, *S. Nilsson.* Petrific. Suecana, p. 32, pl. vi, figs. 1, 2.
— — — *G. P. Deshayes.* Hist. nat. Vers et Mollusques (Encycl. méthod.), vol. iv, pl. clxxxvii, figs. 1, 2; pl. clxxxviii, figs. 1, 2.
1832. — carinata, *Deshayes.* Ibid., vol. ii, p. 301; Planches, vol. iv, pl. clxxxvii, figs. 3—5.
1833. — — *A. Goldfuss.* Petref. Germ., vol. ii, p. 9, pl. lxxiv, fig. 6.
— — pectinata, *Goldfuss.* Ibid., p. 9, pl. lxxiv, fig. 7.
— — prionota, *Goldfuss.* Ibid., p. 10, pl. lxxiv, fig. 8.
— — serrata, *Goldfuss.* Ibid., p. 10, pl. lxxiv, fig. 9.
— — diluviana, *Goldfuss.* Ibid., p. 11, pl. lxxv, fig. 4.
1835. Alectryonia Defrancii, *G. Fischer de Waldheim.* Bull. Soc. Impér. Nat. Moscou, vol. viii, p. 113, pl. iii.
? — — Ferussaci, *Fischer de Waldheim.* Ibid., p. 111, pl. iv.
1836. Ostrea retusa, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 338, 361, pl. xiv, fig. 4.
1837. — diluviana, *W. Hisinger.* Lethæa Suecica, p. 49, pl. xiv, fig. 5.
— — — *F. Dujardin.* Mém. Soc. géol. de France, vol. ii, p. 230.
? — — gregaria, *F. C. L. Koch and W. Dunker.* Beitr. nord-deutsch. Oolithgebild., p. 50, pl. vi, fig. 2.
1839. — rectangularis, *F. A. Römer.* Verstein. nord-deutsch. Oolithengeb., Nachtrag, p. 24, pl. xviii, fig. 15.
— — diluviana?, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 19.
1841. — macroptera, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 45.
— — carinata, *Römer.* Ibid., p. 45.
— — serrata, *Römer.* Ibid., p. 45.
1845. — carinata et O. prionota, *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 250.
1845–6. — diluviana, *H. B. Geinitz.* Grundr. d. Verstein., p. 478.
1846. — carinata, *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 38.
— — diluviana, *Reuss.* Ibid., p. 38, pl. xxx, figs. 16, 17; pl. xli, fig. 1; pl. xlv, fig. 1.
— — carinata, *A. Leymerie.* Statist. géol. min. de l'Aube, Atlas, pl. v, fig. 19.
— — pes-leonis, *E. Forbes.* Trans. Geol. Soc., ser. 2, vol. vii, p. 156, pl. xviii, fig. 5.
1847. — macroptera, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 695, pl. cccclxv.
— — carinata, *d'Orbigny.* Ibid., vol. iii, p. 714, pl. cccclxxiv, figs. 1—5.

1847. Ostrea frons, *d'Orbigny*. Ibid., vol. iii, p. 733, pl. cccclxxxiii.
— — Milletiana, *d'Orbigny*. Ibid., p. 712, pl. cccclxxii, figs. 5—7.
— — diluviana, *d'Orbigny*. Ibid., p. 728, pl. cccclxxx.
1849. — macroptera, *T. Brown*. Illustr. Foss. Conch. Gt. Brit. and Ireland, p. 146, pl. lviii, figs. 1, 2.
— — carinata, *Brown*. Ibid., p. 146, pl. lix, fig. 6.
1850. — — *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 170.
— — frons, *d'Orbigny*. Ibid., p. 255.
— — macroptera, *d'Orbigny*. Ibid., pp. 84, 120.
— — Ricordeana, *d'Orbigny*. Ibid., p. 171.
— — Milletiana, *d'Orbigny*. Ibid., p. 139.
— — diluviana, *d'Orbigny*. Ibid., pp. 171, 198.
— — frons et carinata, *H. B. Geinitz*. Das Quadersandst. oder Kreidegeb. in Deutschland, p. 196.
— — diluviana, *Geinitz*. Ibid., p. 198.
1852. — carinata, *F. Römer*. Kreidebild. v. Texas, p. 75, pl. ix, fig. 5.
1851–2. — — *H. G. Bronn*. Lethæa Geogn., ed. 3, vol. ii, p. 262, pl. xxxii, fig. 2.
1853. — Milletiana, *F. J. Pictet and W. Roux*. Moll. Foss. Grès verts de Genève, p. 525, pl. xlix, fig. 3.
1854. — macroptera, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 173.
— — frons, *Morris*. Ibid., ed. 2, p. 173.
1855. — macroptera, *G. Cotteau*. Moll. Foss. de l'Yonne, p. 122.
? 1859. — frons, *T. Wiltshire*. Red Chalk of England (Geol. Assoc.), p. 16, pl. ii, fig. 4.
1863. — diluviana, *A. Kunth*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 724.
1868. — — *E. Eichwald*. Lethæa Rossica, vol. ii, p. 365.
— — frons, *Eichwald*. Ibid., p. 366.
— — carinata, *Eichwald*. Ibid., p. 367.
— — rectangularis, *F. J. Pictet*. Mélanges paléont., p. 263, pl. xl, fig. 9.
1869. — macroptera, *H. Coquand*. Mon. Ostrea, Terr. Crét., p. 164, pl. lxxii, figs. 1—4.
— — rectangularis, *Coquand*. Ibid., p. 187, pl. lxxii, figs. 5—12.
— — pectinata, *Coquand*. Ibid., p. 76, pl. xxix, figs. 1—7 (*O. colubrina*).
— — serrata, *Coquand*. Ibid., p. 79, pl. xvii, fig. 3; pl. xxx, figs. 1—5.
— — carinata, *Coquand*. Ibid., p. 129, pl. xlix, figs. 3—9.
— — Ricordeana, *Coquand*. Ibid., p. 148, pl. liii, figs. 8—12.
— — Milletiana, *Coquand*. Ibid., p. 155, pl. lix, figs. 11—16.
— — diluviana, *Coquand*. Ibid., p. 120, pl. xl, figs. 1—4.
— — rectangularis, *P. de Loriol and V. Gilliéron*. Urgon. infér. de Landeron, p. 25, pl. i, figs. 20—22.
? 1870. — carinata, *F. Römer*. Geol. v. Oberschlesien, p. 333.

1871. Ostrea [Alectryonia] carinata, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 468, pl. xlviii, fig. 5; pl. xlix, figs. 1—2.

— — — pectinata, *Stoliczka.* Ibid., p. 469, pl. xlviii, figs. 1, 2.

— — — diluviana, *Stoliczka.* Ibid., p. 466, pl. xlvi, figs. 1, 2; pl. xlvii, figs. 1, 2.

— — macroptera, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 300, pl. clxxxiv, fig. 5.

— — rectangularis, *Pictet and Campiche.* Ibid., p. 275, pl. clxxxiv, figs. 1—4.

— — Milletiana, *Pictet and Campiche.* Ibid., p. 309, pl. cxciv, figs. 7—9.

— — pectinata, *Pictet and Campiche.* Ibid., p. 321.

1872. — carinata, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 174, pl. xxxix, figs. 6—11.

— — diluviana, *Geinitz.* Ibid., pt. 1, p. 176, pl. xxxix, figs. 1—5.

? — — frons, *Geinitz.* Ibid., pt. 2, p. 30, pl. viii, fig. 12.

1875. — diluviana, *E. Hébert and E. Munier-Chalmas.* Annal. Sci. géol., vol. vi, p. 119.

— — frons, *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxi, p. 295.

1876. — (Alectryonia) diluviana, *D. Brauns.* Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 392.

1878. Alectryonia Zeilleri, *E. Bayle.* Explicat. Carte géol. France, vol. iv. Atlas, pt. 1, pl. clxvi, figs. 1—4.

— — carinata, *Bayle.* Ibid., pl. cxlvii, figs. 1—7.

1881. Ostrea carinata, *J. Gosselet.* Esquisse géol. du Nord, iii, pl. xvii, fig. 4.

? 1882. Alectryonia frons, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 261.

1883. Ostrea diluviana, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iii, Iserschicht., p. 120, fig. 95.

— — frons *var.* macroptera, *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 102.

— — — *var.* carinata, *Keeping.* Ibid., p. 103.

1884. — macroptera, *O. Weerth.* Neocomsandst. im Teutoburg.-Walde (Palæont. Abhandl., vol. ii), p. 55.

— — rectangularis, *Weerth.* Ibid., p. 54.

— — carinata, *C. A. White.* Foss. Ostreidæ N. America (4th Ann. Rep. U. S. Geol. Surv.), p. 293, pl. xliii, figs. 1—4.

1886. Alectryonia macroptera, *H. Trautschold.* Neocom. Sably (Nouv. Mém. Soc. Imp. Nat. Moscou, vol. xv), p. 133.

1888. Ostrea (Alectryonia) diluviana, *G. Müller.* Jahrb. d. k. preuss. geol. Landesanst. für 1887, p. 400.

? 1889. — frons, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iv, Teplitz. Schicht., p. 87, fig. 86.

— — (Alectryonia) frons, *O. Griepenkerl.* Senon. v. Königslutter (Palæont. Abhandl., vol. iv), p. 33.

? 1890. Allectryonia *cf.* carinata, *M. Yokoyama.* Palæontographica, vol. xxxvi, p. 198.

1893. Ostrea frons, *S. Meunier.* Le Naturaliste, p. 175, fig. 1.

— — carinata, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 238.

— — sp. *cf.* diluviana, *Michael.* Ibid., p. 239.

1894. — diluviana, *B. Lundgren.* Mollusk. i *Mammillatus* och *mucronata* zonerna, p. 36.

1895. — (Alectryonia) carinata, *E. Tiessen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvii, p. 462.

— — — *cf.* diluviana, *Tiessen.* Ibid., p. 463.

— — macroptera, *G. Maas.* Ibid., vol. xlvii, p. 271.

— — — *A. Wollemann.* Ibid., vol. xlviii, p. 834.

1897. — carinata, *U. Söhle.* Geognost. Jahresh. (1896), p. 40.

— — — *R. Leonhard.* Palæontographica, vol. xliv, p. 27.

— — diluviana, *A. Hennig.* Revis. Lamellibr. i Nilssons's 'Petrif. Suecana,' p. 16, pl. ii, figs. 1, 2, 5.

— — (Alectryonia) pectinata, *F. Nötling.* U. Cret. (Maestrichtian) Mari Hills (Palæont. Indica, ser. xvi, vol. i), p. 38, pl. ix, figs. 2, 3.

— — — frons, *A. Rutot.* Bull. Soc. Belge Géol. Paléont. et Hydrol., vol. x, p. 24.

? — — frons, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., vi, Chlomek. Schicht., p. 68.

1898. — pectinata, *G. Müller.* Mollusk. Untersen. v. Braunschweig u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., n.f., 25), p. 13, pl. i, fig. 6.

1900. — macroptera, *A. Wollemann.* Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (ibid., n.f., pt. 31), p. 16.

1904. Alectryonia Zeilleri, *H. Douvillé.* Mission Scient. Perse (J. de Morgan), vol. iii, pt. vi, Paléont., p. 277, pl. xxxvi, fig. 16.

1905. Ostrea diluviana, *T. Wegner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 182.

1908. OSTREA (ALECTRYONIA) MACROPTERA, *P. A. Peron.* Compte rendu Assoc. Franç. Avanc. Sci., vol. xxxvi (1907), p. 308.

1910. — — CARINATA, *E. Böse.* Mon. geol. paléont. Cerro de Muleros (Bol. Instit. geol. México, No. 25), p. 104, pl. xvi, figs. 13, 14.

1911. — (ALECTRONIA) CARINATA, *A. Fritsch.* Stud. im Gebiete der bohm. Kreideformat., Korycaner Schicht., p. 48, fig. 218.

— — DILUVIANA, *Fritsch.* Ibid., p. 48, fig. 216.

— ALECTRYONIA DILUVIANA, *K. Vogel v. Falckenstein.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lxii, p. 559.

? — — *cfr.* FRONS, *Vogel v. Falckenstein.* Ibid., p. 559.

Non 1847. OSTREA CARINATA, *J. Müller.* Petref. der Aachen. Kreidef., pt. 1, p. 38, (= *O. Goldfussi*, Holzapfel).

— 1850. — — *J. de C. Sowerby*, in *F. Dixon.* Geol. Sussex, p. 357 (*O. frons*, p. 386, ed. 2), l. xxvii, fig. 2.

— 1852. — FRONS? *R. Kner.* Denkschr. k. Akad. Wissensch. Wien, Math.-Nat. Cl., vol. iii, p. 319, pl. xvii, fig. 10.

— 1883. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iii, Iserschicht., p. 121, fig. 96.

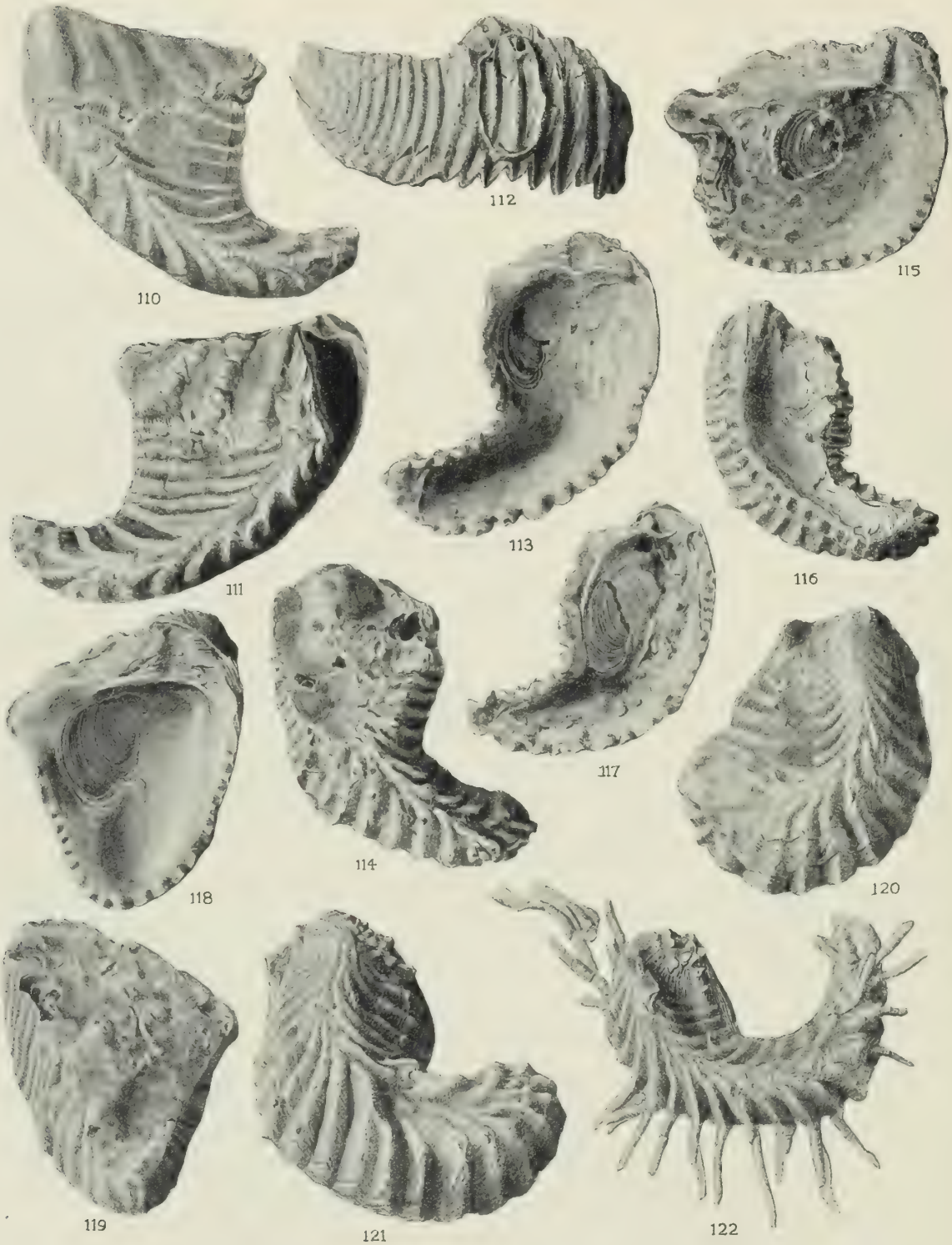
Description.—Shell nearly equivalve; the valves similar except for the attached surface of the left valve. The proportion of height to length varies, but usually the height is much greater than the length, the difference becoming greater with age. Valves usually more or less tapering towards the postero-ventral extremity, but occasionally expanding at the end; slightly, moderately, or considerably curved, occasionally forming a nearly complete volution; sides flattened, so that in the elongate forms each valve is roof-like in section. The thickness (or depth) of the valves increases with age, and in old individuals the shell becomes very thick and possesses a vesicular structure. Umbones small, with a slight or moderate posterior curvature. A posterior wing or ear is usually present, and is of small or moderate size when the attached surface is small, but of large size when the attached surface is large and mainly posterior to the umbo. A small anterior wing is often present, and is best developed in specimens which have a small attached surface. When the attached surface is small or narrow the shell becomes elongate, but when the attached surface is large and broad the shell becomes rounded or oval instead of elongate, and then the posterior ear is usually not distinctly defined.

Figs. 98–109.—*Ostrea diluviana*, L98, 99. Claxby Ironstone, Goulsby. Bristol Museum. Left valve and anterior view. 100–102, Lower Greensand, Atherfield. Museum of Practical Geology, Nos. 25802, 25790, 25795. Right valves and anterior view. 103, Crackers, Atherfield. Same museum, No. 25793. Right valve. 104, 105, Lower Greensand, Upware. Sedgwick Museum. Interior and exterior of a left valve. 106–108, Lower Greensand, Faringdon. 106, 107, Bristol Museum. Left valve. 108, Mr. Treacher's Collection. Right valve. 109, Ferruginous Sands, Shanklin. Sedgwick Museum. Right valve. All × $\frac{5}{6}$.

Valves with strong, usually angular folds which, in the elongate forms, extend from the median line to the margin; the folds are usually somewhat curved, but may be almost straight; the amount of their curvature decreases in passing from the earlier to the later part of the shell. The margins of the two valves interlock by means of sharply pointed tooth-like projections formed by the interspaces between the folds. On the median ridge of the valves the folds are usually irregular, and may bear on each side of the ridge short spines; near the margins of the valves long tubular outgrowths occur in some specimens. The number and size of the folds vary considerably in different individuals; often the later folds are stronger than the earlier ones, and those on the convex side stronger than those on the concave side. The part of the right valve near the umbo is smooth and without folds so long as the corresponding part of the left valve is attached; this portion is commonly small, but becomes extensive when the attached surface of the left valve is large, and then the folds are limited to the relatively small marginal part of the valves. The triangular ligament-pit may be slightly or considerably curved. The adductor impression is oval, and usually not far from the hinge-line.

Affinities.—The examples of this species found in the Lower Cretaceous have been named *O. rectangularis*, Römer, and *O. macroptera*, Römer. Pictet and Campiche, de Loriol, and Weerth regard *O. macroptera* as distinct from *O. rectangularis*, and state that the former differs from the latter principally in the relatively smaller height of the shell, the larger posterior wing, and the larger ribs. D'Orbigny, Maas and Wollemann, on the other hand, consider that the two forms cannot be separated. The last author, after studying a large collection of specimens, states that the height of the shell depends mainly on the age of the individual; that the size of the posterior wing varies greatly, being in some cases quite small, in others very large, and between the two extremes every gradation may be found. The size of the ribs likewise varies. The study of numerous English specimens leads me to endorse Wollemann's view. Pictet and Campiche figured as *O. macroptera* a small example from the Lower Greensand of Atherfield, but larger specimens from the same horizon possess a higher shell like *O. rectangularis*, and cannot be separated from *O. macroptera*.

The examples found in the Lower Cretaceous deposits have been generally regarded as distinct from those in the Upper Cretaceous, which in this country have been usually named *O. frons* or *O. carinata*. The principal distinction is said to be the larger posterior wing in the Lower Cretaceous form. But the study of a large series of specimens shows that in both the Upper and the Lower Cretaceous the size of the wing varies greatly, as well as the height and curvature of the shell, and the number and coarseness of the ribs. As a rule, however, the posterior wing is better developed in the Lower than in the Upper Cretaceous examples,



FIGS. 110–122.—*Ostrea diluviana*, L. Sedgwick Museum, except 120, 121. 110, 111, Lower Greensand, Upware. Left and right valves. 112–119, Lower Greensand, Faringdon. Left valves. 112–114, anterior, interior and exterior of a left valve. 116, 117, interior and exterior of a left valve. 118, 119, interior and exterior of a left valve. 120, 121, zone of *Pecten asper*, Devizes. Museum of Practical Geology, Nos. 25814, 25812. 120, right valve. 121, left valve. 122, Chalk Marl, Folkestone. Left valve. All × $\frac{5}{6}$.

but in some of the former it is small,[1] while in some of the latter it attains a large size (fig. 123), and such specimens are indistinguishable from *O. macroptera*. It seems, therefore, that no line can be drawn between *O. macroptera* and the Upper Cretaceous forms, especially since it is found that the size of the wing is directly related to that of the attached surface of the left valve which was almost certainly determined by external conditions. When the attached surface is large and mainly posterior to the umbo, then the *macroptera* type with a large wing arises.

The examples of this species (here known as *O. diluviana*, L.), found in the Upper Cretaceous deposits, have received numerous names, of which the principal are *O. pectinata*, Lamarck, *O. carinata*, Lamarck, *O. colubrina*, Lamarck, *O. frons*, Parkinson, *O. serrata*, Brongniart, *O. prionota*, Goldfuss, *O. Milletiana*, d'Orbigny, *O. Ricordeana*, d'Orbigny, *O. Zeilleri* (Bayle). In the Upper Cretaceous of England this species is not known to occur above the zone of *Holaster subglobosus* and has been usually named *O. frons* or *O. carinata*, but on the continent of Europe and in other parts of the world it is represented in the higher parts of the Chalk. D'Orbigny and Coquand, believing in the principle that specimens found at different horizons belong to different species, have regarded as distinct forms the following amongst others : *O. Milletiana* from the Gault, *O. carinata* from the Cenomanian, *O. pectinata* (*O. frons*) from the Lower Senonian, *O. serrata* from the Upper Senonian. But later authors have found the greatest difficulty in distinguishing these "species." An examination of a large number of specimens, even when collected from one locality and one horizon only, shows that the shell is extraordinarily variable, and that every gradation is found between the different types ; apart from variation in the number and size of the ribs, the curvature of the shell, etc., there are differences which are obviously due to the size, shape and position of the attached surface. Similar modifications occur at all horizons, and it seems impossible to separate as distinct species the forms found at different levels. Sometimes at one locality or in one kind of deposit a particular form of the shell may be more common than others, and may, if only a small number of specimens are available, give the impression of being a distinct species, but whenever a large collection is made other varieties are found which make it impossible to regard as a species the form which at first sight appeared to be distinct. The difficulty of separating these supposed species is shown by the fact that although d'Orbigny states that *O. frons* is characteristic of the Senonian, yet he includes in his synonymy the specimens figured by Sowerby from the Upper Greensand and Chalk Marl. Similarly, in quoting foreign examples of a "species," authors have sometimes unconsciously cited them from horizons in which they believed the species did not occur.

[1] See, for example, a specimen from the Lower Greensand of Faringdon (figs. 106, 107), in which the left valve was attached to a long narrow object, and the posterior wing is not developed.

Peron (1908) has already recognised that these "species" cannot be accepted. He states that the detailed analysis of the characters attributed to each of the species and the study of their synonymy shows that the *enchaînement* of these diverse forms is complete, and that usually the difference of names corresponds only to difference of stratigraphical horizon.

The form found in the Gault, which was named *O. Milletiana* by d'Orbigny, is considered by Pictet and Campiche to be identical with *O. carinata* of Sowerby from the Upper Greensand and Chalk Marl, which, as already mentioned, is included by d'Orbigny in *O. frons* of the Senonian. Pictet and Campiche quote *O. Milletiana* from the Cambridge Greensand, but this is included by Jukes-Browne in *O. frons*.

O. diluviana, Linnæus, from the Upper Chalk of Sweden, was figured first by Nilsson, and more recently other figures of Swedish specimens have been given by Hennig (1897). D'Orbigny and Coquand recognised that the specimens figured by Nilsson as *O. diluviana* could not be separated from *O. frons*, and the same view is held by Brauns, Lundgren, and Hennig. The two last-named authors state that Nilsson's figures certainly represent Linnæus' species, and Brauns also takes them as types of *O. diluviana*, but excludes the figures given by d'Orbigny, Coquand, Goldfuss and Geinitz. D'Orbigny, on the other hand, takes Hisinger's figure of a specimen from the Upper Chalk of Sweden as the type of Linnæus' *O. diluviana*, and excludes from that species the forms figured by Nilsson, which he regards as belonging to *O. frons*. The examples of *O. diluviana* figured by d'Orbigny, Coquand and Geinitz come from the Cenomanian. In *O. diluviana*, as understood by those authors, the shell is oval or rounded in form instead of being elongate as in the common forms of *O. frons*; at first sight it appears to be quite distinct, and being easily recognisable it has been commonly regarded as a separate species,[1] but Lundgren and Hennig have found in the Swedish Chalk a large number of intermediate forms which link together *O. diluviana* as interpreted by d'Orbigny and *O. diluviana* as figured by Nilsson and Hennig, consequently these two types cannot be any longer regarded as distinct species. Geinitz, although keeping the forms distinct, nevertheless recognises in the Cenomanian of Saxony the existence of intermediate forms, and the same fact is shown by Goldfuss' figures. An oval or rounded form, closely resembling *O. diluviana* as understood by d'Orbigny, is found in the Lower Greensand of Faringdon (figs. 115, 118, 119), and is certainly inseparable from the common elongate form which has been usually named *O. macroptera*; similar remarks apply to a rounded form found occasionally in the Upper Greensand and Chalk Marl of England (figs. 124, 125).

[1] H. Douvillé places this in the "genus" *Lopha* (= *Alectryonia*), and refers the elongate forms (*frons, carinata*, etc.) to the "genus" *Arctostrea*. See 'Bull. Soc. géol. de France,' ser. 4, vol. x (1910), pp. 636, 637.

FIGS. 123–134.—*Ostrea diluviana*, L123, zone of *Schlœnbachia rostrata*, Devizes. Museum of Practical Geology, No. 25820. Right valve. 124, 125, Upper Greensand, Sidmouth. British Museum, L3326. Left valve. 126–130, Chalk Marl, Folkestone. Sedgwick Museum. 126, anterior view. 128–130, right valves. 127, anterior view of 128. 131–133, Base of Chalk Marl, Haslingfield. Sedgwick Museum. Right valves. 134, Cenomanian Sandstone, Wilmington. Sedgwick Museum. Vertical section of left valve. All × $\frac{5}{6}$.

So that this type occurs at three horizons: Aptian, Cenomanian, and Senonian, and its features are obviously due to the large size and rounded form of the attached surface; the shell was attached for such a long period that when it eventually grew free it was unable to develop its usual elongate form, and its ultimate outline was only a little different from that of its attached surface. The coarseness of the ribs varies in the same way as in the elongate forms. In some places, as, for instance, in the Cenomanian of Gamighügel in Saxony, the shell attains a great thickness, but the elongate forms likewise sometimes become very thick.

Figs. 135–138.—*Ostrea diluviana*, L135, zone of *Holaster subglobosus*, Cherry Hinton. Right valve. 136–138, Base of Chalk Marl, Haslingfield, Cambs. 136, 137, Right valves. 138, anterior view of 137. Sedgwick Museum. All × $\frac{5}{6}$.

O. santonensis, d'Orbigny, and *O. carantonensis*, d'Orbigny, are similar to d'Orbigny's *O. diluviana*, and are included by Geinitz in that species.

Remarks.—The shell varies greatly in its curvature, some examples being only slightly bent, while others form almost a complete volution (fig. 123), and between these extremes every gradation is found. The variation in the coarseness of the ribs seems, in some cases at any rate, to be connected with the nature and depth of the sea-floor on which the individuals lived; for example, most of the specimens found in the Chalk Marl have coarse ribs, but those found in the Cenomanian sandstone of Wilmington in Devon have smaller and more numerous ribs. Occasionally folds or ribs are developed on the posterior ear (fig. 135). The long regular outgrowths from the margin of the valves (fig. 122) occur in specimens

from the Chalk Marl, and were no doubt developed for the purpose of fixation in the soft sediment of the sea floor.

In all cases the right valve starts with a smooth stage, and folds are developed later. The smooth stage corresponds with the attached surface of the left valve, since folding does not begin until the margin of that valve grows free from the rock or body to which the shell is fixed. Occasionally, after folding has gone on for some time, a second smooth stage appears on the right valve; this is due to the left valve becoming again attached to a foreign body (fig. 137).

Types.—*O. diluviana*, L., from the Senonian of Sweden. *O. pectinata*, Lamarck, is said to have come from near Dreux (Eure-et-Loire). *O. carinata*, Lamarck, from Carry (Seine-Inférièure). *O. frons*, Parkinson, from France; the locality and horizon are unknown, and the specimen cannot now be found. *O. carinata*, Sowerby, from the Upper Greensand of Chute Farm, near Longleat Park, and from the Chalk Marl of Folkestone, are in the British Museum. *O. serrata*, Cuvier and Brongniart, came from Dreux. *O. macroptera*, Sowerby, from the Lower Greensand of Folkestone, is in the British Museum. *O. retusa*, Sowerby, from the Lower Greensand of Atherfield, cannot be traced.

Distribution.—Claxby Ironstone (zone of *Belemnites lateralis*) of South Willingham. Tealby Limestone (zone of *Belemnites brunsvicensis*) of North Willingham, Lincolnshire. *Perna*-bed of Atherfield. Ferruginous Sands of Atherfield and Shanklin. Recorded by Topley from the Sandgate Beds and Folkestone Beds of Folkestone. Lower Greensand of Faringdon, Brickhill, Potton and Upware.

Upper Gault of Folkestone. Cambridge Greensand. Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown, Devizes, Warminster and Ventnor. Upper Greensand (zone of *Pecten asper*) of Devizes. Chalk Marl (zone of *Schlœnbachia varians*) of Ventnor, Folkestone, Haslingfield, Burwell, etc. Cenomanian Sandstone of Wilmington. Cenomanian (Meÿer's Bed 12) of Dunscombe. Zone of *Holaster subglobosus* of Cherry Hinton and Burwell.

Ostrea Leymerii, *Leymerie* [ex Deshayes], 1842. Text-figs. 139, 140.

1842. Ostrea Leymerii, [Deshayes, MS.], *A. Leymerie.* Mém. Soc. géol. de France, vol. v, pp. 11, 28, pl. xiii, fig. 4.
1845. — — *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 250.
1843. — — *A. Leymerie.* Statist. géol. min. de l'Aube, Atlas, pl. vii, fig. 2.
1847. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 704, pl. cccclxix, figs. 1—3.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 108.
1854. — Leymeriei, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 173.

1855. Ostrea Leymerii, *G. Cotteau.* Moll. Foss. de l'Yonne, p. 122.
1860. — — *A. Gaudry.* Bull. Soc. géol. de France, ser. 2, vol. xvii, p. 30.
? 1861. — — *P. de Loriol.* Anim. Invert. Foss. Mt. Salève, p. 112.

Fig. 139.—*Ostrea Leymerii*, Leym. *Mammillatus*-bed, Okeford Fitzpaine. British Museum, No. L11597. Right valve. × ¾.

1869. — — *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 179, pl. lxx, figs. 14—17; pl. lxxi, figs. 6, 7.
— — Leymeriei, *P. de Loriol and V. Gillieron.* Urgon. Infér. du Landeron, p. 27.
1871. — Leymerii, *F. J. Pictet and G. Campiche.* Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 296, pl. cc, figs. 1, 2.

1878. Ostreum Leymeriei, *E. Bayle.* Explicat. Carte géol. de France, vol. iv, Atlas, pt. 1, pl. cxxx, figs. 1, 2.

1897. Ostrea Leymeriei, *R. B. Newton.* Proc. Dorset Nat. Hist. and Antiq. Field Club, vol. xviii, p. 73, pl. i, fig. 3.

Description.—Shell large, very thick in old specimens, higher than long; usually slightly or only moderately inequilateral; outline ovate, oval, subtrigonal or subquadrate. Left valve slightly or moderately convex; right valve often flattened. Umbonal part sometimes narrow, sometimes broad. Umbo straight or

Fig. 140.—*Ostrea Leymerii*, Leym. *Mammillatus*-bed, Okeford Fitzpaine. British Museum, No. L. 11591. Interior of part of right valve. × $\frac{2}{3}$.

slightly curved; area large, high. Surface of valves sometimes smooth, except for growth-lamellæ, sometimes with radial folds. Attached surface of variable size.

Affinities.—This species seems to be related to *O. Germaini*, Coquand. It also, as de Loriol pointed out, shows some resemblance to some forms of *Exogyra sinuata* in which the umbo is only slightly curved; but whether it has any real relationship to that species cannot at present be determined. See also *O. cunabula* (below).

Type.—From the Barremian of Aube.

Distribution.—Hythe Beds of Aylesford, Kent. *Mammillatus*-bed of Okeford Fitzpaine, Dorset. Recorded by Fitton from the *Perna*-bed and Ferruginous Sands of Atherfield. Recorded by Topley from the Atherfield Beds of Peasmarsh and Sevenoaks.

OSTREA CUNABULA, *Seeley*, 1861. Text-figs. 141, 142.

1861. OSTREA CUNABULA, *H. G. Seeley*. Ann. Mag. Nat. Hist., ser. 3, vol. vii, p. 117, pl. v, fig. 1.
— . — LAGENA, *Seeley*. Ibid., p. 117, pl. v, fig. 2.

Description.—Shell higher than long, either nearly equilateral or slightly or

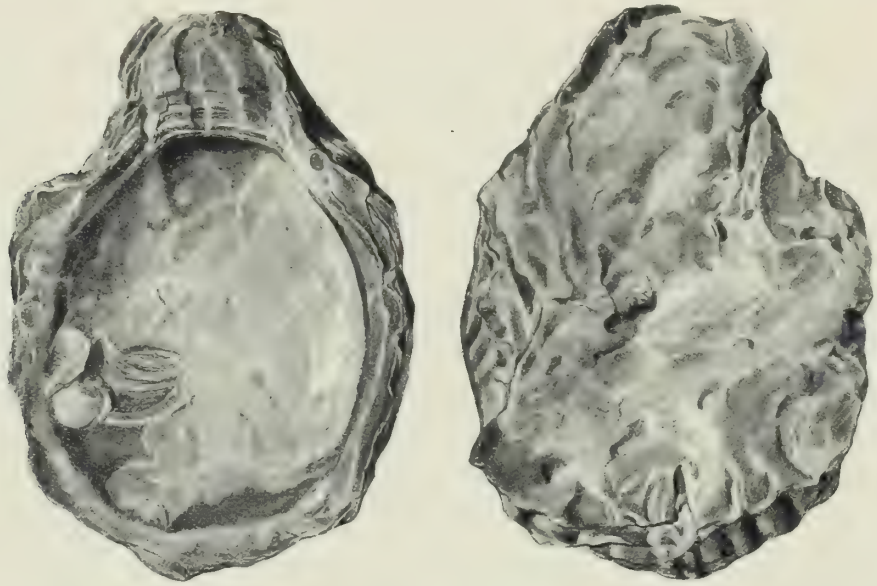


FIG. 141.—*Ostrea cunabula*, Seel. Cambridge Greensand (base of Chalk Marl). Sedgwick Museum. Cambridge. The type of *O. lagena*, Seel. Interior and exterior of left valve. × $\frac{5}{6}$.

moderately inequilateral; when nearly equilateral the outline is often ovate or oval.

Left valve with the attached surface either small and near the umbo only, or large—sometimes extending to the greater part of the valve; in the former case the valve is very convex, in the latter slightly convex or flattened. Umbonal part usually narrow and pointed. Area large, usually higher than long; sometimes in the plane of the valves and nearly symmetrical; in other cases curving inwards, outwards or backwards. Surface usually with numerous, rounded, radiating ribs crossed by growth-ridges. Adductor impression deep, near the posterior margin, oval or more or less quadrate. Right valve nearly flat, with growth-lines only.

Affinities.—*O. cunabula* is closely allied to and may be only a variety of

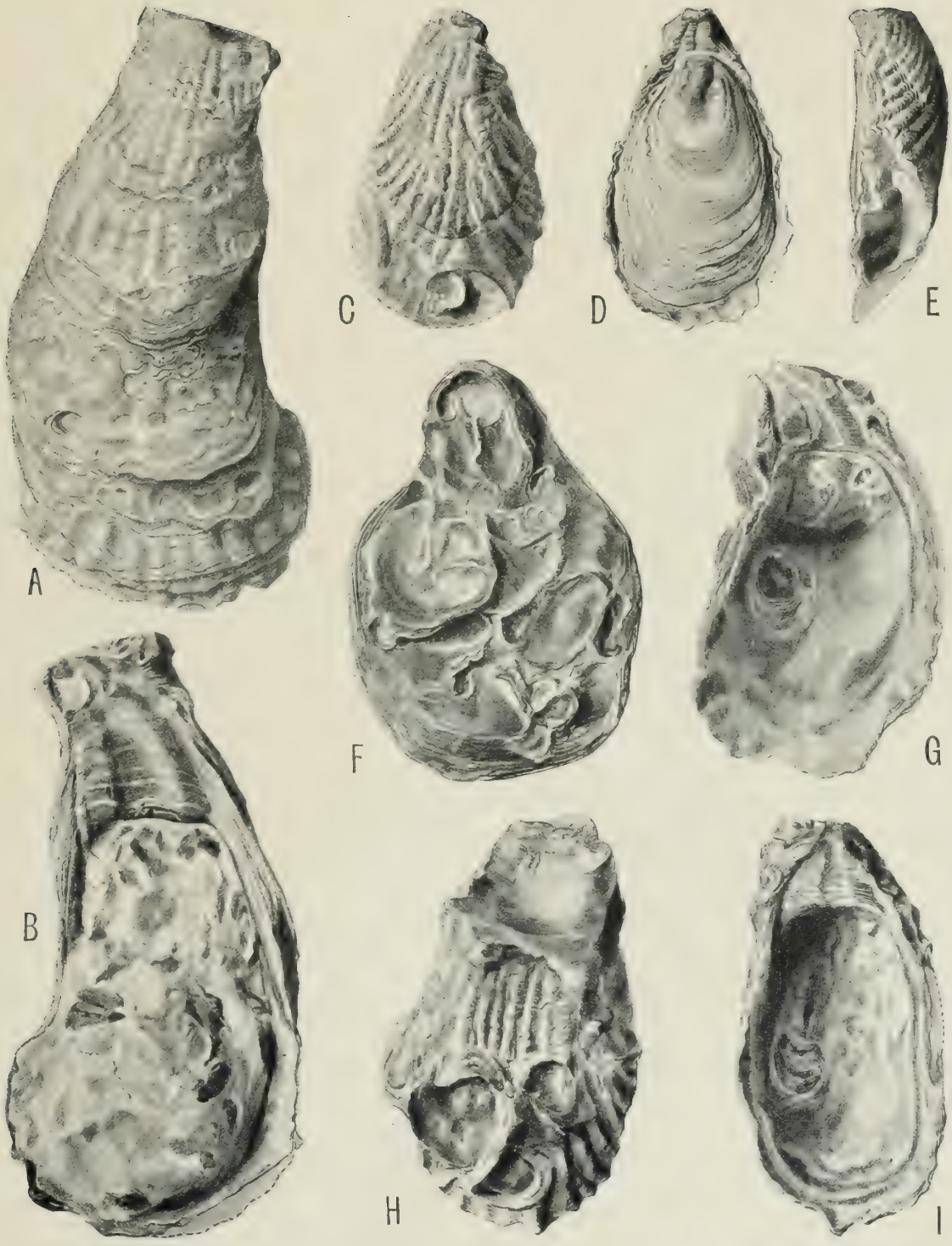


Fig. 142.—*Ostrea cunabula*, Seel. Cambridge Greensand (base of Chalk Marl). A, B, British Museum, No. 67740. C–I, Sedgwick Museum. A, B, left valve. C, left; D. right valve; E, anterior view of C, D. F, right valve with other oysters on the surface. G, left valve. H, I, exterior and interior of a left valve. All × $\frac{5}{6}$.

O. Leymerii, from which it appears to differ in its somewhat smaller ribs. The forms with a small surface of attachment resemble *O. baissanensis*, Böhm,[1] but have coarser and less regular ribs. *O. lagena*, Seeley (fig. 141), is a form of *O. cunabula* with a very large attached surface, and consequently a less convex left valve.

Types.—From the Cambridge Greensand (indigenous). The type of *O. lagena* is in the Sedgwick Museum, Cambridge; the type of *O. cunabula* cannot be found, but other specimens named by Seeley are in the Sedgwick Museum.

Distribution.—Cambridge Greensand (base of Chalk Marl), Cambridge. Chalk Marl of Burwell.

Ostrea Walkeri, *Keeping*, 1883. Plate LV, figs. 1—3.

1883. Ostrea Walkeri, *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 103, pl. iv, fig. 4.

Remarks.—This form is similar to *O. Germaini* and *O. Leymerii*; the chief difference mentioned by Keeping—the inequality of the valves—is not constant, and is determined by the size of the attached surface. Harbort regards *O. Walkeri* as a synonym of *O. Germaini*, Coquand,[2] but the material available is hardly sufficient for definite determination. Some of the specimens with a large attached surface resemble *O. Osmana*, Wollemann.[3]

Type.—In the Sedgwick Museum, Cambridge.

Distribution.—Lower Greensand of Upware.

Ostrea vesicularis, *Lamarck*, 1806. Plate LV, figs. 4—9. Text-figures. 143—182.

1779. — *B. Faujas-St.-Fond.* Hist. nat. Mte. St. Pierre de Maestricht, pl. xxii, fig. 4; pl. xxv, figs. 2, 5.

1806. Ostrea vesicularis, *Lamarck.* Ann. Mus. Hist. nat., vol. viii, p. 160, and vol. xiv (1809), p. 375, pl. xxii, fig. 3.

— — deltoidea, *Lamarck.* Ibid., p. 160; vol. xiv (1809), p. 374, pl. xxi, fig. 3 (non *deltoidea*, Sowerby).

1816. — , *W. Smith.* Strata identif. Organised Fossils, p. 7, pl. iii, figs. 5—7.

1819. — vesicularis, *Lamarck.* Animaux sans Vert., vol. vi, p. 219.

1820. — convexa, *T. Say.* Amer. Journ. Sci., vol. ii, p. 42.

[1] 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. li (1899), p. 466, pl. xxix, figs. 1—3.

[2] Coquand, 'Mon. Ostrea, Terr. Crét.' (1869), p. 191, pl. lxvi, figs. 14—16. Pictet and Campiche, 'Terr. Crét. Ste. Croix' ('Matér. Pal. Suisse,' ser. 5, 1871), p. 295, pl. clxxxix, figs. 1—6. Wollemann, 'Bivalv. u. Gastrop. deutsch. u. holländisch. Neocoms' (1900), p. 18, pl. i, fig. 4. Harbort, 'Fauna Schaumburg-Lippe'schen Kreidemulde' (1905), p. 28.

[3] Op. cit. (1900), p. 19, pl. i, fig. 5, pl. ii, fig. 1.

1822. Ostrea vesicularis, *A. Brongniart.* In Cuvier, Ossemens Foss., vol. ii, p. 598, pl. iii, fig. 5.

1823. Gryphæa globosa, *J. de C. Sowerby.* Min. Conch., vol. iv, p. 127, pl. cccxcii.

1827. Ostrea vesicularis, *S. Nilsson.* Petrific. Suecana, p. 29, pl. vii, figs. 3—5; pl. viii, figs. 5, 6.

— — hippopodium, *Nilsson.* Ibid., p. 30, pl. vii, fig. 1.

— — clavata, *Nilsson.* Ibid., p. 30, pl. vii, fig. 2.

1828. Gryphæa convexa, *S. G. Morton.* Journ. Acad. Nat. Sci. Philad., vol. vi, p. 79, pl. iv, figs. 1, 2.

— — mutabilis, *Morton.* Ibid., p. 81, pl. iv, fig. 3.

1832. — expansa, *J. de C. Sowerby.* In Sedgwick and Murchison, Trans. Geol. Soc., ser. 2, vol. iii, pp. 349, 418, pl. xxxviii, fig. 5.

— Ostrea vesicularis, *G. P. Deshayes.* Hist. nat. Vers et Mollusques (Encycl. méthod.), vol. ii, p. 291.

1833. — — *A. Goldfuss.* Petref. Germ., vol. ii, p. 23, pl. lxxxi, fig. 2.

— — hippopodium, *Goldfuss.* Ibid., p. 23, pl. lxxxi, fig. 1.

1834. Gryphæa convexa, *S. G. Morton.* Synopsis Org. Remains Cret. U. States, p. 53, pl. iv, figs. 1, 2.

— — mutabilis, *Morton.* Ibid., p. 53, pl. iv, fig. 3.

? 1835. Pycnodonte radiata, *G. Fischer de Waldheim.* Bull. Soc. Imp. Nat. Moscou, vol. viii, p. 119, pl. i.

1837. Ostrea vesicularis, *W. Hisinger.* Lethæa Suecica, p. 46, pl. xii, fig. 2.

— — hippopodium, *Hisinger.* Ibid., p. 47, pl. xiii, fig. 4.

— — clavata, *Hisinger.* Ibid., p. 47, pl. xiii, fig. 3.

— Gryphæa similis, *G. G. Pusch.* Polens Paläont., p. 34, pl. iv, fig. 12.

— Ostrea vesicularis, *A. d'Archiac.* Mém. Soc. géol. de France, vol. ii, p. 183.

? — — proboscidea, *d'Archiac.* Ibid., p. 184, pl. xi, fig. 9.

? — — vesicularis, *F. Dujardin.* Ibid., vol. ii, p. 229.

1838. Gryphæa vesicularis, *H. G. Bronn.* Lethæa Geogn., vol. ii, p. 264, pl. xxxii, fig. 1.

1842. — (Ostrea) vesicularis, *F. v. Hagenow.* Neues Jahrb. für Min., etc., p. 548.

1845. Gryphæa vesicularis, *H. B. Geinitz.* Grundr. d. Verstein., p. 483, pl. xx, figs. 17, 18.

1845. Ostrea vesicularis, *A. d'Orbigny.* In Murchison, de Verneuil and de Keyserling, Géol. Russie de l'Europe, vol. ii, p. 491.

1846. — — *A. Leymerie.* Statist. géol. min. de l'Aube, Atlas, pl. iv, fig. 1.

— — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 37, pl. xxix, figs. 21, 22; pl. xxx, figs. 1—8.

— hippopodium, *Reuss.* Ibid., p. 39, pl. xxviii, figs. 10—15, 17, 18 pl. xxix, figs. 1—18; pl. xxx, figs. 13, 14 (? *partim*).

1847. Ostrea hippopodium, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 731, pl. cccclxxxi, figs. 4—6; pl. cccclxxxii.

vesicularis, *d'Orbigny.* Ibid., p. 742, pl. cccclxxxvii.

— — — *J. Müller.* Petref. der Aachen. Kreidef., pt. 1, p. 37.

— — hippopodium, *Müller.* Ibid., p. 39.

1849. Gryphæa globosa, *J. Brown.* Illustr. Foss. Conch. Great Britain and Ireland, p. 148, pl. lxi, fig. 2.

1850. — — *var.* depressa, *J. de C. Sowerby,* in *F. Dixon.* Geol. Sussex, p. 357, pl. xxvii, fig. 3.

— Ostrea sp., *Sowerby.* Ibid., p. 357, pl. xxviii, figs. 22, 23.

— Gryphæa vesicularis, *R. Kner.* Kreidemerg. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 30.

— Ostrea vesicularis, *A. Alth.* Geogn.-palæont. Beschreib. v. Lemberg (ibid., vol. iii, pt. 2), p. 252.

? — — hippopodium, *Alth.* Ibid., p. 253, pl. xiii, fig. 3.

— — vesicularis, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 256.

— — Lesueuri, *d'Orbigny.* Ibid., p. 171.

? 1851. — Nilssoni, *J. Müller.* Petrefact. Aachen. Kreideformat., pt. 2, p. 70.

— vesicularis, *A. Leymerie.* Mém. Soc. géol. de France, ser. 2, vol. iv, p. 202, pl. x, figs. 2, 3.

1851–2. Gryphæa vesicularis, *H. G. Bronn* and *F. Römer.* Lethæa Geogn., ed. 3, vol. ii, pt. 5, p. 264, pl. xxxii, fig. 1.

1852. — — *R. Kner.* Denkschr. Akad. Wissensch. Wien, Math.-nat. Cl., vol. iii, p. 319.

? — Ostrea vesicularis *var.* aucella, *F. Römer.* Kreidebild. v. Texas, p. 74, pl. ix, fig. 4.

1854. — hippopodium, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 173.

— — vesicularis, *Morris.* Ibid., p. 174.

1863. Gryphæa vesicularis, *K. E. Schafhäutl.* Süd-Bayerns Lethæa Geogn., p. 143, pl. xli, figs. 5, 6.

— Ostrea vesicularis, *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, pp. 127, 157.

1864. — vesiculosa, *S. P. Woodward.* Geol. Mag., vol. i, p. 112, pl. v, fig. 6.

1865. — uncinella, *A. Leymerie.* Bull. Soc. géol. de France, ser. 2,vol. xxii, p. 367.

1866. — (Gryphæa) vesicularis, *K. A. Zittel.* Bivalv. d. Gosaugeb. (Denkschr. Akad. Wissensch. Wien, Math.-nat. Cl., vol. xxv, pt. ii), p. 123 [47], pl. xix, fig. 6 (? *partim*).

1867. — vesicularis, *B. Lundgren.* Palæont. Iakttag. Fäxekalk. Limhamn, p. 23.

? — — — *O. Fraas.* Aus dem Orient, i, p. 88.

? 1868. — hippopodium, *E. Eichwald.* Lethæa Rossica, vol. ii, p. 387, pl. xix, fig. 5.

— Gryphæa vesicularis, *Eichwald.* Ibid., p. 394.

1869. Ostrea vesicularis, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 35, pl. xiii, figs. 2—10.
— — hippopodium, *Coquand.* Ibid., p. 100, pl. xviii, figs. 1, 4, 5; pl. xix; pl. xx, figs. 1—8.
— — Lesueuri, *Coquand.* Ibid., p. 146, pl. xli, figs. 1—4.
— — proboscidea, *Coquand.* Ibid., p. 72, pl. xv, fig. 10; pl. xvi, figs. 1—12; pl. xviii, figs. 1—5.
— — vesicularis, *E. Favre.* Moll. Foss. de Lemberg, p. 160.
— — hippopodium, *Favre.* Ibid., p. 161.
1870. — — *F. Römer.* Geol. v. Oberschles., p. 315, pl. xxxvii, fig. 7.
— — vesicularis, *H. Credner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxii, p. 225.
— — — *C. Schlüter.* Neues Jahrb. für Min., etc., p. 952.
1871. Gryphæa vesicularis, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 465, pl. xlii, figs. 2—4; pl. xliii, fig. 1; pl. xlv, figs. 7—12.
1872. Ostrea hippopodium, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 177, pl. xxxix, figs. 12—27; pl. xl, figs. 1—3; pt. 2, pl. viii, figs. 5—7.
1873. — vesicularis, *J. I. Lahusen.* Foss. White Chalk of Simbirsk (Imp. Russ. Min. Corps Instit.), pt. 2, p. 249.
— — — *var.* judaica, *L. Lartet.* Annal. Sci. géol., vol. iii, p. 69, pl. xi, figs. 8—10.
1875. — — *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxi, p. 295 (*partim*).
? 1876. Gryphæa vesicularis (?), *F. B. Meek.* Invert. Cret. and Tert. Foss. U. Missouri, p. 20, pl. xi, fig. 2; pl. xvi, fig. 8.
— Ostrea hippopodium, *D. Brauns.* Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 394.
1877. — — *A. Fritsch.* Stud. im Geb. böhmisch. Kreideformat., ii, Weissenberg. u. Malnitz. Schicht., p. 140, fig. 137.
? 1878. — vesicularis, *O. Fraas.* Aus dem Orient, ii, p. 86.
— — — *J. de C. Sowerby*, in *F. Dixon.* Geol. Sussex, ed. 2, p. 386, pl. xxvii, fig. 3,
— Pycnodonta vesicularis, *E. Bayle.* Explic. Carte géol. France, vol. iv, Atlas, pt. 1, pl. cxxxv, figs. 1—7.
— proboscidea, *Bayle.* Ibid., pl. cxxxvi, figs. 1, 2.
— Ostrea hippopodium, *C. Barrois.* Ann. Soc. géol. Nord, vol. v, p. 407.
— — — *G. Behrens.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxx, p. 260.
1881. Avicula filata, *R. Etheridge*, in *Penning* and *Jukes-Browne.* Geol. Cambridge, p. 144, pl. ii, fig. 3.
? 1882. Ostrea *cf.* hippopodium, *R. Windmöller.* Jahrb. d. k. preuss. geol. Landesanst., für 1881, p. 29.

1882. Gryphæa vesicularis, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 259.
— Ostrea hippopodium, *Schröder.* Ibid., p. 259.
1883. — — *A. Fritsch.* Stud. im Geb. böhmisch. Kreideformat., iii, Iserschicht., p. 122, fig. 98.
1884. Gryphæa vesicularis, *C. A. White.* 4th Ann. Rep. U. S. Geol. Survey, p. 303, pl. xlviii, figs. 1—5.
1885. — — *R. P. Whitfield.* Brach. and Lamellibr. Raritan Clays (Mon. U. S. Geol. Surv., vol. ix), p. 36, pl. iii, figs. 15, 16; pl. iv, figs. 1—3; pl. v.
1888. — — *G. Müller.* Jahrb. d. k. preuss. geol. Landesanst., für 1887, p. 401.
— Ostrea vesicularis, *A. Peron.* Hist. Terr. Craie S.E. Bassin Anglo-Parisien, p. 179.
1889. — (Gryphæa) vesicularis, *O. Griepenkerl.* Palæont. Abhandl., vol. iv, p. 37.
— — hippopodium, *E. Holzapfel.* Die Mollusk. Aachen Kreide (Palæontographica, vol. xxxv), p. 252, pl. xxix, figs. 3—7.
— Gryphæa vesicularis, *Holzapfel.* Ibid., p. 253, pl. xxix, figs. 1, 2.
1890. — — *M. Blanckenhorn.* Beitr. Geol. Syriens, p. 75.
1890–91. Ostrea hippopodium, *A. Peron.* Brachiopodes etc., Terr. Crét. Hauts-Plateaux de la Tunisie, p. 152.
— — vesicularis, *Peron.* Ibid., p. 175.
? 1891. Gryphæa vesicularis, *J. Böhm.* Palæontographica, vol. xxxviii, p. 91, pl. iv, fig. 3.
— Ostrea hippopodium, *Böhm.* Ibid., p. 92, pl. iv, fig. 12.
1892. — — *E. Stolley.* Mittheil. a. d. Min. Institut. Univ. Kiel, vol. i, p. 235.
— Gryphæa vesicularis, *Stolley.* Ibid., p. 236.
— Ostrea vesicularis, *F. Vogel.* Verhandl. nat. Vereins preuss. Rheinl., vol. xlix, p. 51.
1894. — — *A. Hennig.* Geol. Fören. i Stockholm Förhandl., vol. xvi, p. 513.
hippopodium, *Hennig.* Ibid., p. 514.
— vesicularis, *B. Lundgren.* Mollusk. i *Mammillatus* och *Mucronata* zonerna, p. 35.
— — hippopodium, *Lundgren.* Ibid., p. 36.
1895. — (Gryphæa) vesicularis, *F. Vogel.* Holländisch. Kreide, p. 7.
— — hippopodium, *Vogel.* Ibid., p. 7.
— (Gryphæa) hippopodium, *E. Tiessen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvii, p. 464.
? — Gryphæa vesicularis, *J. F. Whiteaves.* Trans. Roy. Soc. Canada, ser. 2, vol. i, p. 120.
1897. Ostrea hippopodium, *A. Hennig.* Revis. Lamellibr. Nilsson's "Petrif. Suecana," p. 6, pl. i, figs. 1—6, 8, 9.
— — vesicularis, *Hennig.* Ibid., p. 18.
— — hippopodium, *R. Leonard.* Palæontographica, vol. xliv, p. 51.

1897. Gryphæa vesicularis, *F. Nötling.* U. Cret. (Mæstrichtian) Mari Hills (Palæont. Indica, ser. xvi, vol. i), p. 39, pl. x, figs. 1, 2.

— Ostrea vesicularis, *A. Rutot.* Bull. Soc. Belge Géol. Pal. et Hydrol., vol. x, p. 26.

— — hippopodium, *Rutot.* Ibid., p. 26.

1898. — — *G. Müller.* Molluskenfauna Untersen. v. Braunschweig u. Ilsede, p. 14, pl. iii, figs. 10—15; pl. iv, figs. 1, 2.

1899. — — *G. de Alessandri.* Palæontogr. Italica, vol. iv, p. 200.

— Ostrea hippopodium, *Alessandri.* Ibid., p. 199.

1900. Ostrea (Gryphæa) vesicularis, *C. Mayer-Eymar.* Eclogæ Geol. Helvet., vol. vi, p. 121.

1901. Gryphæa vesicularis, *A. Wollemann.* Jahrb. d. k. preuss. geol. Landesanst., vol. xxi, p. 14.

1901. Gryphæa vesicularis, *H. Imkeller.* Palæontographica, vol. xlviii, p. 40, pl. ii, figs. 2—4; pl. iii, figs. 7—9.

1901–02. Ostrea (Pycnodonta) vesicularis, *P. Choffat.* Faun. Crét. Portugal, vol. i, ser. 3, p. 103, pl. ii, fig. 18.

1902. Gryphæa vesicularis, *A. Wollemann.* Lüneburg. Kreide (Abhandl. d. k. preuss. geol. Landesanst., n.f., 37), p. 52.

— Ostrea hippopodium, *J. P. J. Ravn.* Mollusk. i Danmarks Kridtafl. I. Lamellibr., p. 114.

— Gryphæa vesicularis, *Ravn.* Ibid., p. 116.

— — — *J. Wanner.* Palæontographica, vol. xxx (2), p. 119, pl. xvii, figs. 10—12.

— — — *E. Dacqué.* Ibid., p. 188, pl. xxii, figs. 1, 2.

— — — *J. A. Taff.* Chalk of S. W. Arkansas (22nd Ann. Rep. U.S. Geol. Surv., pt. iii), pls. l—lii.

1903. Ostrea vesicularis, *R. Fortau.* Bull. Inst. Égyptien, ser. 4, vol. iv, p. 308.

? — Gryphæa vesicularis, *J. F. Whiteaves.* Mesoz. Foss. (Geol. Surv. Canada), vol. i, p. 401.

1904. Pycnodonta vesicularis, *H. Douvillé.* Mission Scient. en Perse par J. de Morgan, vol. iii, pt. 4, Paléont., p. 278, pl. xxxvi, fig. 23.

1905. Gryphæa vesicularis, *T. Wegner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 184.

— Ostrea vesicularis, *A. D. Arkhangelsky.* Ann. géol. min. Russie, vol. vii, pp. 190, 205, pl. iv, figs. 1, 2.

1906. Gryphæa vesicularis, *E. Böse.* Fauna Senon. Cárdenas (Bol. Instit. geol. México, No. 24), p. 49, pl. iv, figs. 1—3; pl. vii, fig. 2; pl. ix, fig. 4; pl. xii, fig. 6.

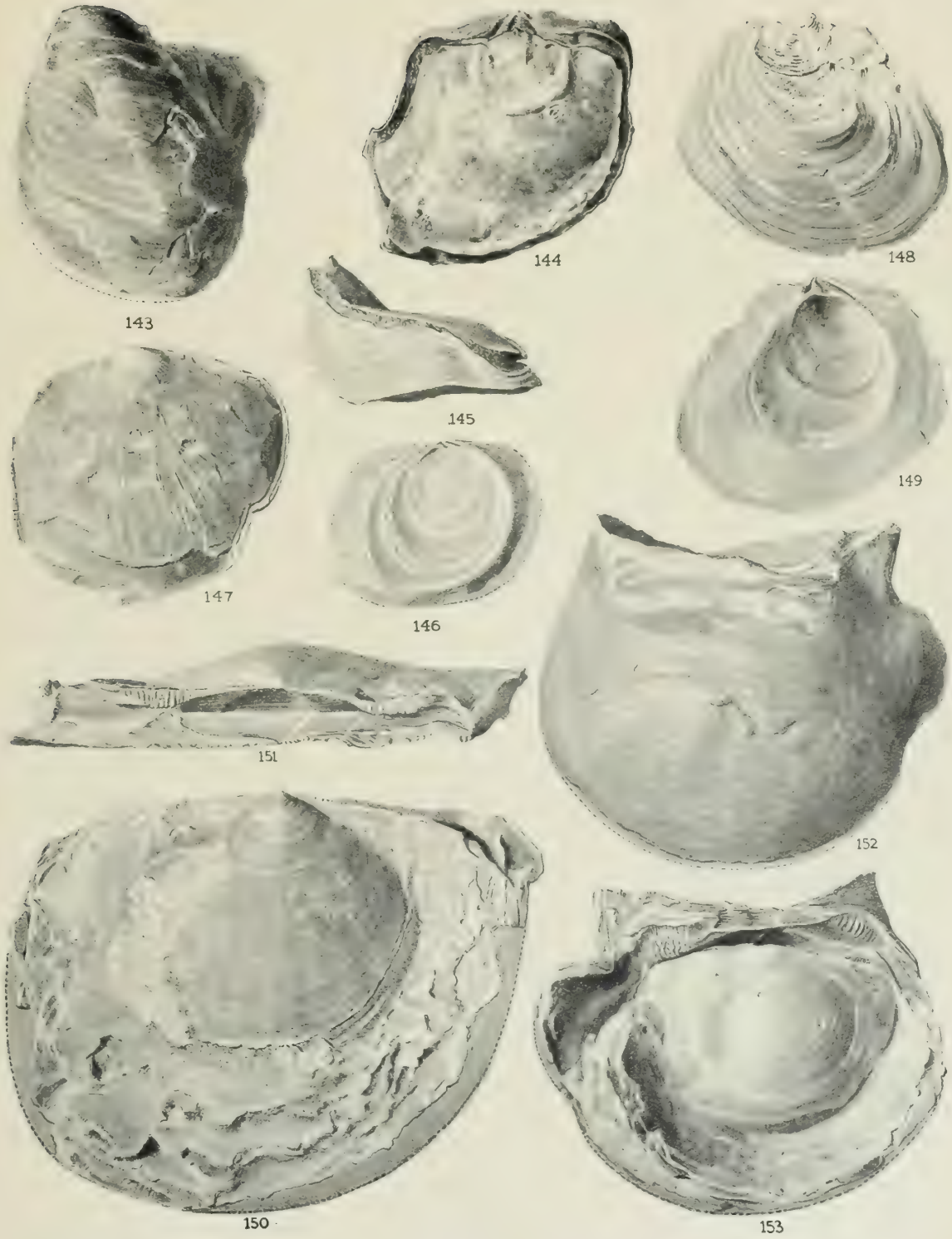
1906. Ostrea (Gryphæa) vesicularis, *M. Boule* and *A. Thevenin.* Annal. Paléont., vol. i, p. 49 [7], pl. ii, fig. 3.
? — Gryphæa vesicularis, *J. Pethö.* Palæontographica, vol. lii, p. 188, pl. xii, figs. 2, 3.
1907. — convexa, *S. Weller.* Cret. Pal. New Jersey, p. 451, pl. xlv.
1910. — vesicularis, *F. Frech.* Neues Jahrb. für Min., etc., i, p. 6, pl. ii, fig. 1.
? — Ostrea vesicularis, *H. Brüggen.* Ibid., Beil.-Band xxx, p. 744.
1911. — hippopodium, *A. Fritsch.* Stud. im Geb. böhmisch. Kreideformat., Korycaner Schicht., p. 48, fig. 217.
? — Gryphea vesicularis, *M. E. Vadász.* Mitteil. Jahrb. ungarisch. geol. Reichsanst., vol. xix, p. 110, pl. iii, fig. 3.
— Ostrea hippopodium, *W. Rogala.* Bull. Internat. Acad. Sci. Cracovie, p. 167.
— — — *K. Vogel von Falckenstein.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lxii, p. 558.
— Gryphæa vesicularis, *v. Falckenstein.* Ibid., p. 560.

Non 1859. Ostrea vesicularis, *T. Wiltshire.* Red Chalk of England (Geol. Assoc.), p. 16, pl. ii, fig. 5.

Description.—The *left* valve, when attached by only a very small part of the umbo, has a grypheate form, being usually very convex, and with the umbo prominent and incurved; the outline of the valve is rounded, but the posterior part is more or less produced; the postero-dorsal part is often convex and sometimes distinctly limited from the remainder of the valve; this convex part when strongly developed may be produced backwards in a wing-like form. In large specimens of the grypheate form this valve becomes very thick.

When the left valve is attached to a larger surface of more or less rounded outline it is still grypheate in form, but with the umbonal region truncated owing to the attached surface being flat or concave. When the attached surface is still larger, relatively to the entire shell, the free marginal part possesses the same character as the corresponding part of the grypheate form, and this free part grows upwards from the attached surface. When nearly all the valve is attached then only a narrow rim grows upwards at the margin; lastly, in some cases the entire valve is attached so that the whole of it is flat or concave; in the interior of such forms a few distinct concentric ridges are often found at intervals, and from the outermost of these the marginal part of the valve becomes gradually thinner and usually shows a porous structure.

When the left valve is attached to a cylindrical or other elongate object, the form of the shell depends on the direction of the long axis of the attached surface. If the axis is nearly perpendicular to or forms a considerable angle with the plane



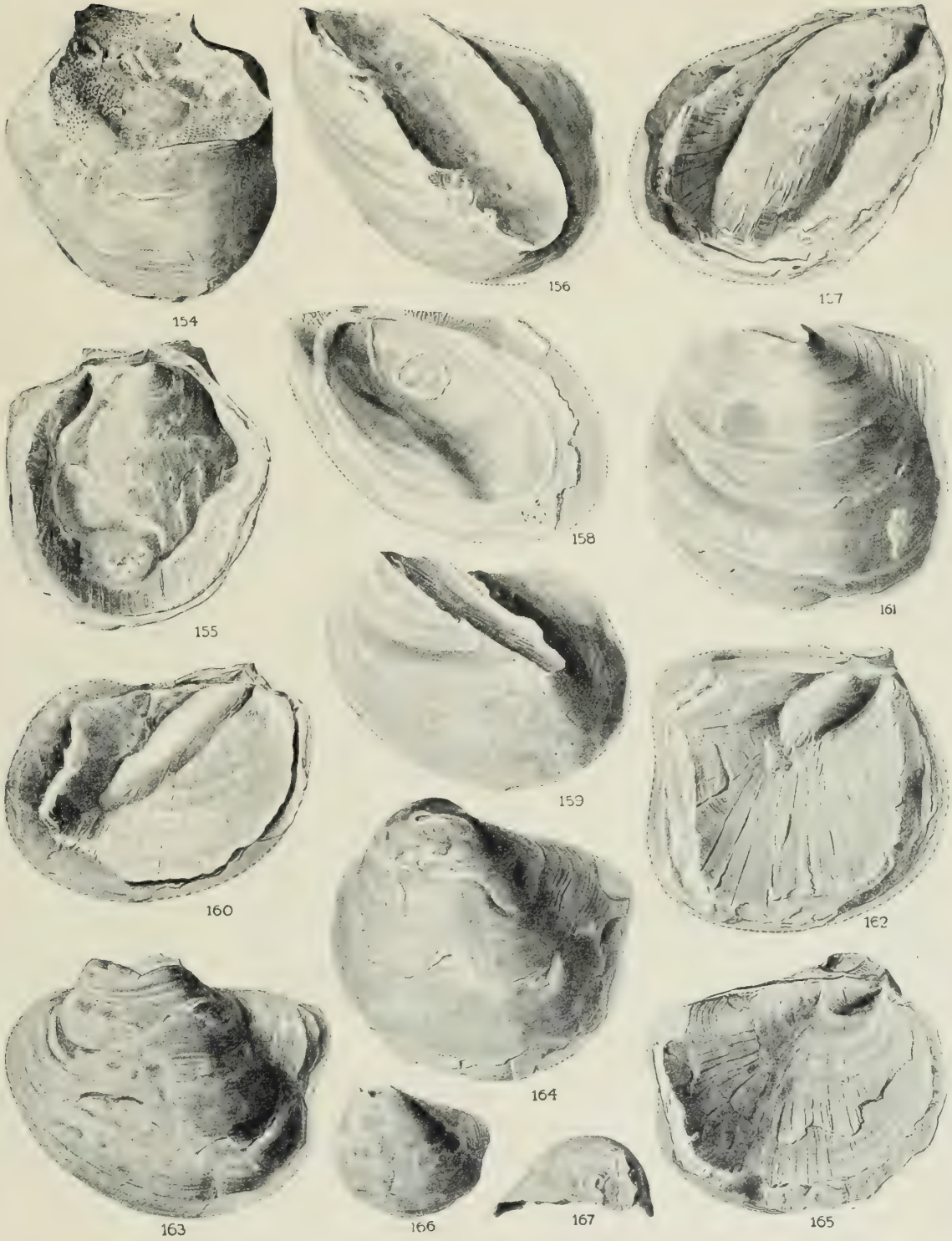
FIGS. 143–153.—*Ostrea vesicularis*, Lam. 143–145. Upper Greensand (zone of *P. asper*), Warminster. Museum of Practical Geology, Nos. 25948, 25950. 143, left valve. 144, right valve. 145, anterior view of 144 showing both valves. 146. Zone of *Micraster cor-anguinum*, Witherington, Dr. Blackmore's Collection. Interior of left valve. 147. Zone of *Actinocamax quadratus*, East Harnham. Same Collection. Right valve. The left valve is entirely attached to the convex surface of an echinoid. 148, 149. Zone of *Micraster cor-anguinum*, Gravesend. British Museum, No. L. 20991. Exterior and interior of a left valve. 150–153. Zone of *Belemnitella mucronata*, Norwich. 150, right valve, British Museum, No. L. 20616. 151, Dorsal view of 150 showing both valves; the left valve entirely attached to a nearly flat surface. 152, 153. Sedgwick Museum. Left and right valves. 146, 147, natural size. Other figures × $\frac{5}{6}$.

of the valves the left valve becomes convex; if the axis is more or less parallel to the plane of the valves and to the hinge-line the left valve is less convex; and if in such cases the attached surface is mainly in front of the umbo then the anterior part of the shell becomes elongated, whereas, when the attached surface is mainly posterior to the umbo the posterior part of the shell become elongated and the shell more inequilateral; if the long axis of the attached surface extends from the umbo in a postero-ventral direction the shell becomes oblique and very inequilateral. Occasionally the left valve shows two surfaces of attachment, one at the umbo, the other at some distance from it. Since the direction of growth depends mainly on the position of the attached surface, it is obvious that the relative length and height will be determined in the same way.

The surface of the free part of the left valve is smooth except for growth-lines. The form and direction of the umbo, area and ligament-pit depend on the mode of attachment. The area is either nearly parallel to the attached surface or slopes gently from the hinge-line to the umbo, and consequently in the grypheate forms it eventually becomes more or less nearly perpendicular to the plane of the valves of the adult shell, but in completely attached forms the area and ligament-pit remain nearly parallel to the plane of the valves; between these two extremes every gradation can be traced. The ligament-pit and the umbo may curve forwards or backwards, or be perpendicular to the hinge-line. Small, irregular, rounded ridges or crenulations, more or less nearly at right angles to the margin of the valve, are seen on the inside of the shell on each side of the area, but are most developed on the posterior side. The adductor impression is rounded or slightly oval.

The *right* valve in the grypheate form with a very small attached surface is almost entirely concave or sometimes nearly flat. The part of the right valve which corresponds to the attached part of the left valve is more or less convex, and reproduces the detailed markings as well as the general form of the attached surface; when the latter is flat the corresponding part of the right valve is only slightly convex, and its convexity increases with that of the attached surface. As soon as the left valve grows free from the attached body the corresponding part of the right valve becomes concave and grows upwards at a considerable angle with the earlier convex part. When the entire left valve is attached the whole of the right valve is slightly convex and there is no upward growth of the marginal part. When the outer layer of the right valve is well preserved fine thread-like radial ribs are seen; they are widely separated and either straight or slightly irregular. The inner margin near the area has small ridges like those of the left valve.

Affinities.—The study of a large series of specimens shows clearly that *Ostrea hippopodium*, Nilsson, is only a form of *O. vesicularis* in which the entire or almost the entire surface of the left valve is attached, and consequently that valve is



FIGS. 154–167.—*Ostrea vesicularis*, Lam. Zone of *Belemnitella mucronata*, Norwich. Sedgwick Museum, Cambridge; except 156, 157, in Dr. Rowe's collection. 154, 156, 159, 161, 163, 164, 166, left valves. 155, right valve of 154. 157, right valve of 156. 158, interior of a right valve similar to 157. 160, right valve of 159. 162, right valve of 161. 165, right valve of 164. 167, dorsal view of 166. 166 and 167, natural size. Other figures × $\frac{5}{6}$.

either nearly flat (fig. 151) or grows upward near the margin only (fig. 145), and the right valve is either slightly convex throughout (figs. 147, 150) or with a narrow marginal part growing upwards (fig. 155). Although this type differs greatly in appearance from the grypheate form (fig. 182), yet every stage between the two extremes can be seen since there is a complete gradation from forms in which the entire surface is attached to forms in which only a very small part of the umbo is fixed. But whatever the form of the shell the part, if any, which grows free shows similar characters. This view of the relationship of *O. hippopodium* and *O. vesicularis* has already been maintained by Peron (1890) and by Müller (1898).

In the Chalk of this country numerous examples of the left valve of an oyster attached completely to flat or convex objects are found and have been commonly referred to *O. Normaniana*, d'Orbigny[1] (fig. 146). The right valve is nearly always missing. The marginal part of the left valve thins away rapidly to a sharp edge and this part usually shows a porous structure, whilst on the inner part of the valve a few distinct concentric ridges are seen ; some of these specimens are young individuals and many are probably immature ; the concentric ridges probably indicate the beginning of an upward growth of the margin which was soon discontinued and the attached growth resumed. Similar concentric ridges are present in some undoubted examples of *O. vesicularis* (figs. 148, 149), and the identity of this form with *O. vesicularis* is proved by the occasional preservation in its original position of the right valve (Plate LV, fig. 4; text-fig. 147) showing the characteristic radial ornamentation of *O. vesicularis*. A left valve of this form is figured by Geinitz[2] as *O. hippopodium*.

Avicula filata, Etheridge, from the Totternhoe Stone (zone of *Holaster subglobosus*) of Burwell, is founded on a right valve of a small specimen of *O. vesicularis*, and shows clearly the fine radial ribs. It agrees with small specimens attached throughout or with only the margin free, found in the Upper and Lower Chalk as well as in the Gault[3] (Plate LV, figs. 4, 5, 7; text-fig. 147).

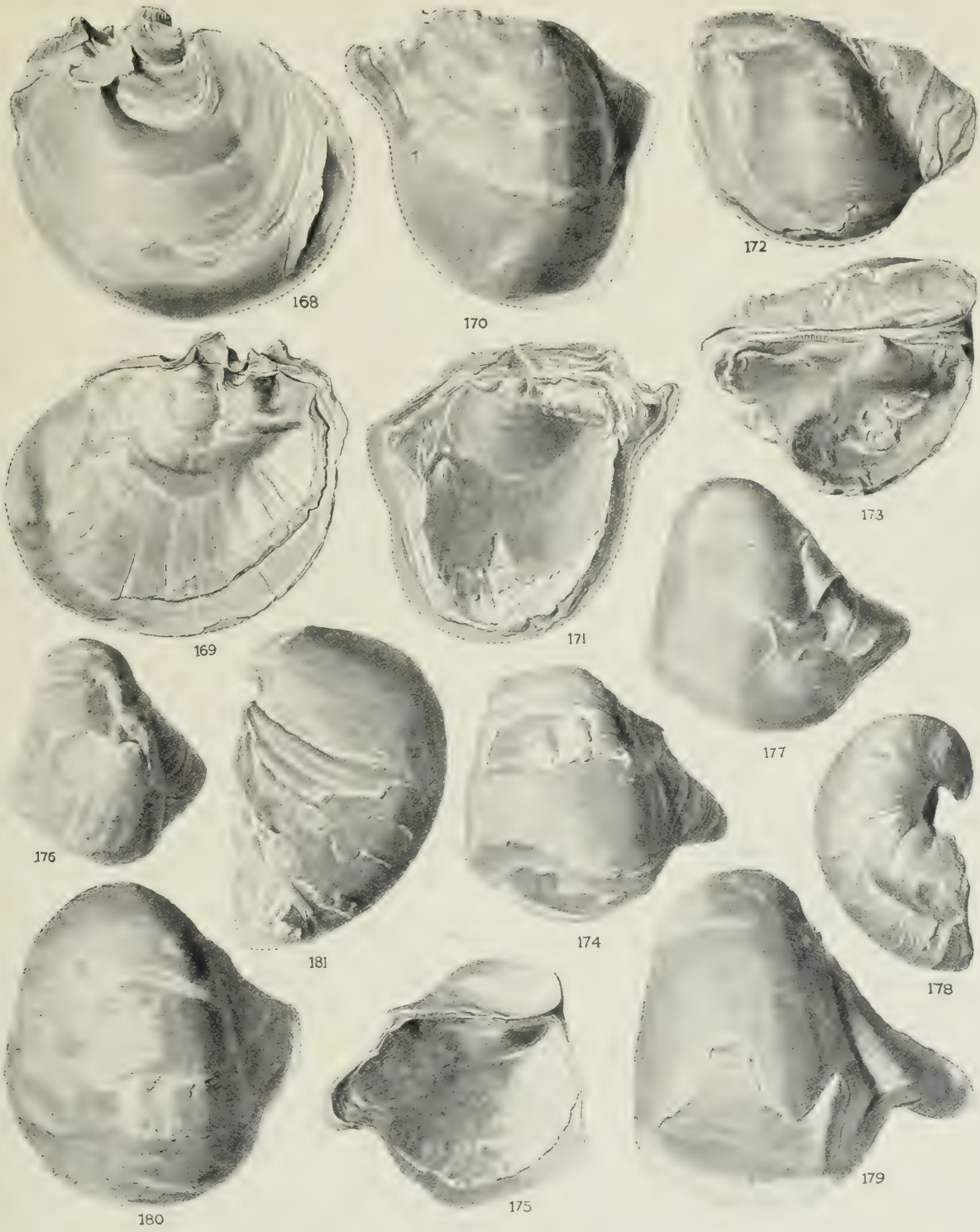
O. clavata, Nilsson, is a form in which the posterior part is more produced than usual owing to the position of the attached surface.

The *hippopodium* form of *O. vesicularis* found in the Cenomanian was named *O. Lesueuri* by d'Orbigny on account of its lower horizon. But Hennig, who has studied a series of Cenomanian specimens, sees no reason for separating it from the Senonian examples, and Müller (1898) likewise includes it in *O. vesicularis*.

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 746, pl. cccclxxxviii, figs. 1—3.

[2] 'Palæontographica,' vol. xx, pt. 2, pl. viii, fig. 6.

[3] *Anomia subradiata*, Reuss, is probably a small example of *O. vesicularis* similar to *Avicula filata* of Etheridge. Reuss, 'Die Verstein. der böhm. Kreideformat.,' pt. 2 (1846), p. 45, pl. xxxi, fig. 19.



FIGS. 168–181.—*Ostrea vesicularis*, Lam. Zone of *Belemnitella mucronata*, Norwich. 168, 169, left and right valves. Norwich Museum, No. 2133. 170, 171, left and right valves. Dr. Rowe's Collection. 172, 173, left and right valves. Sedgwick Museum. 174, 175, left and right valves. Norwich Museum. 176–179, left valves. Sedgwick Museum. 178, posterior view of 177. 180, 181, left valve. Dr. Rowe's Collection. 181, anterior view of 180. All × $\frac{5}{6}$.

O. proboscidea, d'Archiac, is included by Zittel and by G. Müller in *O. vesicularis*, and the latter points out its probable close connection with *O. biauriculata*, Lamarck. The type of *O. proboscidea* from the Santonian of Saintes, Dordogne, is not quite satisfactory, but most of the specimens figured by Coquand seem to be inseparable from *O. vesicularis*.

The grypheate forms of *O. vesicularis* have been usually placed in the "genus" *Gryphæa*, and the *hippopodium* forms in *Ostrea*; in the case of this species, at any rate, "*Gryphæa*" cannot be accepted as a genus.[1]

In the Lower Chalk (Plate LV, figs. 8, 9) a small grypheate form[2] varying only to a small extent in dimensions is common and is not usually associated with larger forms; the uniformity in size and character of this form at first give the impression that it may be a distinct variety, but comparison with the small forms of *O. vesicularis* from the Upper Chalk (figs. 166, 167) shows that they cannot be separated; their small size was probably due to local conditions. Further, it may be noted that in earlier beds (the Upper Greensand) large forms of both the grypheate and *hippopodium* types occur (figs. 143—145), and are indistinguishable from those found in the Upper Chalk. Some rather small grypheate forms are also found in the Gault and Cambridge Greensand, and also forms with all or the larger part of the left valve attached, but they are not common in the Gault.

A few specimens of a small oyster have been found in the Lower Greensand of Atherfield and Shanklin, and show the fine radial ribs on the right valve[3]; some of these, and probably all, are examples of *O. vesicularis*, but the left valves are not, in all cases, well preserved.[4]

Remarks.—O. vesicularis attains its greatest development in the zones of *Belemnitella mucronata* and *Ostrea lunata* in this country, where the grypheate forms are abundant and reach a large size. The form with the posterior wing-like projection (figs. 174–179) occurs mainly in the zone of *B. mucronata*. *O. vesicularis* has been observed attached to sponges, corals, echinoids, oysters, *Inoceramus*, *Spondylus*, gasteropods, Ammonites, and *Belemnitella*. The long range in time and the wide geographical distribution of this species have already been noted by Hennig and other authors.

Types.—O. vesicularis, Lamarck, and *O. deltoidea*, Lamarck, from the Upper Chalk of Meudon. *Gryphæa globosa*, Sowerby, from the zone of *Belemnitella*

[1] This conclusion is in agreement with Peron's views on the "genera" of the Ostreidæ; see 'Descript. Brach., etc., Terr. Crét. Tunisie' (1890—91), pp. 107—109.

[2] A similar but rather larger form occurs in the Melbourn Rock and *plenus*-marls.

[3] Examples of this are figured in vol. i, pl. v, figs. 4, 5.

[4] *Ostrea virgata*, Sowerby, possesses numerous fine radial ribs. The type is the only specimen known; it was found in the Lower Chalk (probably zone of *Holaster subglobosus*) of Sussex. The affinities of this form cannot be determined. Dixon, 'Geol. Sussex' (1850), p. 357, pl. xxvii, fig. 1.

mucronata of Norwich, is in the British Museum. *O. hippopodium*, Nilsson, from the Upper Chalk of Kopinge, is in the Lund Museum. The specimens of *O. hippopodium* figured by Goldfuss from the Cenomanian of Essen, are in the Munich Museum. The examples of *O. vesicularis* figured by William Smith came from Norwich and are in the British Museum. The original of *Gryphæa globosa* var. *depressa*, Sowerby (in Dixon), cannot be found; the specimens of *Ostrea* figured by the same author (Dixon, pl. xxviii, figs. 22, 23), from the zone of *Holaster subglobosus* near Warminster, are in the British Museum. The specimen figured by S. P. Woodward as *O. vesiculosa* from the Upper Chalk of Sussex, is also in that Museum. *Avicula filata*, Etheridge, from the Totternhoe Stone of Burwell, is in the Sedgwick Museum.

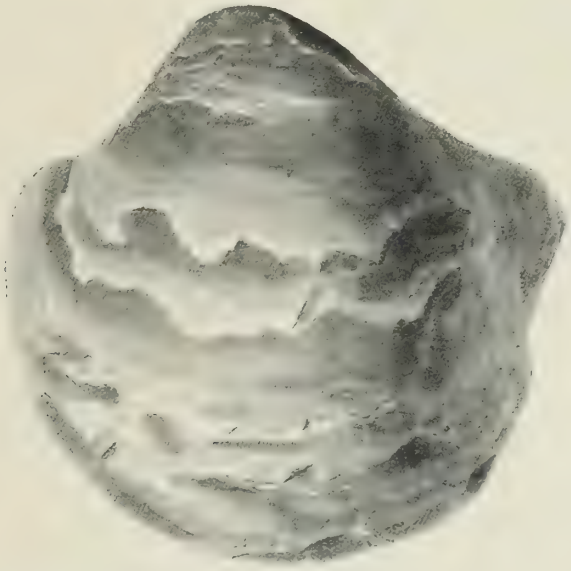


Fig. 182.—*Ostrea vesicularis*, Lam. Zone of *Ostrea lunata*, Trimingham. Dr. Rowe's Collection. Left valve. × $\frac{5}{6}$.

Distribution.—Lower Greensand (Ferruginous Sands) of Shanklin. Gault of Folkestone. Cambridge Greensand. Upper Greensand (zone of *Schlænbachia rostrata*) of the Isle of Wight. Upper Greensand (zone of *Pecten asper*) of Warminster.

Chalk Marl (zone of *Schlænbachia varians*) of Folkestone, Offham, and Burwell. Cenomanian (Meÿer's bed 11) of Beer Head. Cenomanian Sandstone of Wilmington.

Zone of *Holaster subglobosus* of Chilcomb (Hants), Glynde (Lewes), Burham, Arlesey, Ickleford (near Hitchin), Cherry Hinton, Burwell, and Isleham.

Zone of *Rhynchonella Cuvieri* of the South Devon coast and Dover. Melbourn Rock, Melbourn.

Zone of *Terebratulina lata* of the South Devon coast, Dover, Cuxton, Charing, and Beachy Head.

Zone of *Holaster planus* of Mupe Bay, Borstal, West Wratting, Cheveley, and Swaffham (Norfolk).

Zone of *Micraster cor-testudinarium* of Borstal Manor, Chatham, and Stevenage.

Zone of *Micraster cor-anguinum* of Witherington, Quidhampton, Camp Hill (near Salisbury), Northfleet, Gravesend, and the Thanet coast.

Zone of *Marsupites testudinarius* of the Thanet coast. *Uintacrinus* band of Devizes Road (Salisbury).

Zone of *Actinocamax quadratus* of Whaddon, East and West Harnham, Fareham, Shawford, and Bishops Waltham.

Zone of *Belemnitella mucronata* of the Dorset coast and Norwich.

Zone of *Ostrea lunata* of Trimingham.

Ostrea vesiculosa (*Sowerby*), 1822. Plate LV, figs. 10—14; Plate LVI, fig. 1.

1822. Gryphæa vesiculosa, *J. Sowerby*. Min. Conch., vol. iv, p. 93, pl. cccIxix.

? 1847. Ostrea vasculum, *A. d'Archiac*. Mém. Soc. géol. de France, ser. 2, vol. ii, p. 312, pl. xvi, figs. 5, 6.

1849. Gryphæa vesiculosa, *T. Brown*. Illustr. Foss. Conch. Gt. Brit. and Ireland, p. 149, pl. lxi, figs. 8, 9.

1850. Ostrea vesiculosa, *E. Guéranger*. Bull. Soc. géol. de France, ser. 2, vol. vii, p. 802.

1854. Gryphæa vesiculosa, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 168.

? 1868. Ostrea columba, *A. Briart and F. L. Cornet*. Meule de Bracquegnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 46, pl. iv, figs. 13—15.

1869. — vesiculosa, *H. Coquand*. Mon. Ostrea, Terr. Crét., p. 152, pl. lix, figs. 4—7.

1871. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 311, pl. cxciv, figs. 1—6.

— Gryphæa vesiculosa, *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 466, pl. xxxix, figs. 1, 2.

1882. — — *G. Seguenza*. Atti R. Accad. Lincei, ser. 3, Cl. Sci. Fis. Math., vol. xii, p. 182, pl. xix, fig. 2.

1890–91. Ostrea vesiculosa, *A. Peron*. Descript. Brach., etc., Terr. Crét. Tunisie, p. 126.

1903. — — *R. Fortau*. Bull. Inst. Égyptien, ser. 4, vol. iv, p. 290.

? 1908. Gryphæa *aff.* vesiculosa, *F. Favre*. Neues Jahrb. für Min., etc., Beil.-Bd. xxv, p. 609.

Non 1864. Ostrea vesiculosa, *S. P. Woodward*. Geol. Mag., vol. i, p. 112, pl. v, fig. 6.

Description.—Left valve usually thick, very convex, grypheate, more or less oval, height usually considerably greater than the length; slightly or moderately inequilateral, sometimes with a rounded ridge extending from the umbo to the postero-ventral extremity. Posterior part often convex and separated from the remainder of the valve by a furrow. Umbo sharp, prominent, more or less incurved, and usually with a small posterior curvature; surface of attachment generally small. Area and ligament-pit high, straight or with a small backward curvature. Adductor impression oval or rounded. Right valve thin, concave. Surface of both valves smooth, except for growth-lines.

Affinities.—This species is closely allied to *O. vesicularis*, but the umbo is more pointed, usually less incurved and with a smaller attached surface; the area is higher, and usually the height of the shell is relatively greater in proportion to its length. Most of these differences are probably to be accounted for by the small size of the attached surface.

Type.—From the Upper Greensand of Warminster, in the British Museum.

Distribution.—Upper Greensand: common in the zone of *Schlœnbachia rostrata* of Ventnor, Warminster, Dinton and Potterne; rare in the zone of *Pecten asper* of Ventnor, Warminster, and Ballard Down (Swanage). Chloritic Marl of Compton Bay, Isle of Wight.

OSTREA CANALICULATA (*Sowerby*), 1813. Plate LVI, figs. 2–16.

1813. CHAMA CANALICULATA, *J. Sowerby.* Min. Conch., vol. i, p. 68, pl. xxvi, fig. 1 (non *Ostrea canaliculata*, Sowerby.)
1821. OSTREA CANALICULATA, *M. J. L. Defrance.* Dict. Sci. nat., vol. xxii, p. 26.
1827. OSTREA LATERALIS, *S. Nilsson.* Petrific. Suecana, p. 29, pl. vii, figs. 7—10.
— CHAMA CONICA, *Nilsson.* Ibid., p. 28, pl. viii, fig. 4.
1829. GRYPHÆA CANALICULATA, *J. de C. Sowerby.* Min. Conch., vol. vi, p. 218.
— EXOGYRA UNDATA, *Sowerby.* Ibid., vol. vi, p. 220, pl. dcv, figs. 5—7.
1833. OSTREA LATERALIS, *A. Goldfuss.* Petref. Germ., vol. ii, p. 24, pl. lxxxii, fig. 1.
? 1834. GRYPHÆA VOMER, *S. G. Morton.* Synopsis Organic Remains Cret. U. States, p. 54, pl. ix, fig. 5.
1837. OSTREA LATERALIS, *W. Hisinger.* Lethæa Suecica, p. 46, pl. xiii, fig. 1.
— AMPHIDONTE UNDATA, *G. G. Pusch.* Polens Paläont., p. 39.
1842. EXOGYRA PARVULA, *A. Leymerie.* Mém. Soc. géol. de France, ser. 2, vol. v, p. 17, pl. xii, figs. 8, 9.
1845–6. OSTREA LATERALIS, *H. B. Geinitz.* Grundriss d. Verstein., p. 480, pl. xx, fig. 22.
1846. EXOGYRA LATERALIS, *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 42, pl. xxvii, figs. 38—47.
1847. OSTREA CANALICULATA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 709, pl. cccclxxi, figs. 4—8.

1847. Exogyra lateralis, *J. Müller.* Petref. der Aachen. Kreidef., pt. 1, p. 40.
1849. Gryphæa undata, *T. Brown.* Illustr. Foss. Conch., Gt. Britain and Ireland, p. 149, pl. lx, figs. 14, 15.
— — canaliculata, *Brown.* Ibid., p. 149, pl. lxi, fig. 18.
1850. Ostrea canaliculata, *A. d'Orbigny.* Prodr. de Pal., vol. ii, pp. 139, 170, 255.
? 1852. — cyrtoma, *R. Kner.* Denkschr. Akad. Wissensch. Wien., Math.-nat. Cl., vol. iii, p. 320, pl. xvii, fig. 11.
1853. — canaliculata, *F. J. Pictet and W. Roux.* Moll. Foss. Grès verts de Genève, p. 522, pl. l, fig. 2.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 173.
— Exogyra lateralis, *Morris.* Ibid., p. 167.
1863. Ostrea lateralis, *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 110.
— Exogyra lateralis, *H. Drescher.* Ibid., vol. xv, p. 357.
1867. Ostrea lateralis, *B. Lundgren.* Palæont. Iakttag. Fäxekalk. Limhamn, p. 23.
1868. Exogyra lateralis, *E. Eichwald.* Lethæa Rossica, vol. ii, p. 398.
1869. Ostrea canaliculata, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 128, pl. xlv, figs. 13, 14; pl. xlvii, figs. 7—10; pl. lii, fig. 13; pl. lx, figs. 13—15.
— — lateralis, *Coquand.* Ibid., p. 96, pl. xviii, fig. 12; pl. xxx, figs. 10—14.
1870. Exogyra lateralis, *F. Römer.* Geol. v. Oberschles., p. 341, pl. xxix, figs, 4, 5.
? — Ostrea lateralis, *H. Credner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxii, p. 228.
1871. — canaliculata, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 305, pl. cxciii, figs. 4—14.
— Exogyra canaliculata, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 463, pl. xlviii, figs. 6—8.
1872. Ostrea (Exogyra) lateralis, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. i), p. 179, pl. xli, figs. 28—35; pt. ii, pl. viii, figs. 15—17.
1877. Exogyra lateralis, *A. Fritsch.* Stud. im Geb. böhmisch. Kreideformat., ii, Weissenberg. u. Malnitz. Schicht., p. 140, fig. 136.
1881. Ostrea lateralis, *J. Gosselet.* Esquisse géol. du Nord, pl. xvii, fig. 14.
1882. Exogyra lateralis, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 261.

1882. Exogyra canaliculata, *G. Seguenza.* Atti R. Accad. Lincei, ser. 3, Cl. Sci. Fis. Math., vol. xii, p. 176.

1883. — lateralis, *Fritsch.* Op. cit., iii, Iserschicht., p. 118.

? 1887. — *cf.* lateralis, *F. Frech.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxix, p. 153.

1888. Ostrea canaliculata, *A. Peron.* Hist. Terr. de Craie S.E. Bassin Anglo-Parisien, p. 175.

— Exogyra canaliculata, *G. Müller.* Jahrb. d. k. preuss. geol. Landesanst. für 1887, p. 401.

1889. Exogyra lateralis, *Fritsch.* Op. cit., iv, Teplitz. Schicht., p. 86.

— Ostrea (Exogyra) lateralis, *O. Griepenkerl.* Senon v. Königslutter (Palæont. Abhandl., vol. iv), p. 36.

— Exogyra lateralis, *E. Holzapfel.* Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 256.

1890—91. Ostrea canaliculata, *A. Peron.* Descript. Brachiop., etc., Terr. Crét. Tunisie, p. 163.

1893. Exogyra lateralis, *Fritsch.* Op. cit., Priesen. Schicht., p. 102.

1894. Ostrea lateralis, *A. Hennig.* Geol. Fören. i Stockholm, Förhandl., vol. xvi, p. 513.

1895. — (Exogyra) lateralis, *F. Vogel.* Holländisch. Kreide, p. 13.

? — Exogyra *cf.* canaliculata, *E. Tiessen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvii, p. 465.

1896. Ostrea canaliculata, *A. J. Jukes-Browne and W. Hill.* Quart. Journ. Geol. Soc., vol. lii, p. 149.

1897. — lateralis, *A. Hennig.* Revision Lamellibr. i Nilsson's 'Petrif. Suecana,' p. 23.

— Exogyra lateralis, *Fritsch.* Op. cit., vi, Chlomek. Schicht., p. 68.

— — — *R. Leonhard.* Palæontographica, vol. xliv, p. 50.

— — — *A. Rutot.* Bull. Soc. Belge Géol. Pal. et Hydrol., vol. x, p. 27.

— — canaliculata, *R. B. Newton.* Proc. Dorset Nat. Hist. and Antiq. Field Club, vol. xviii, p. 91, pl. iii, figs. 7, 8.

1898. Ostrea canaliculata, *R. Fortau.* Bull. Inst. Égyptien, ser. 4, vol. iv, p. 292.

— Exogyra lateralis, *G. Müller.* Mollusk. Untersen. v. Braunschweig u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., N.F., 25), p. 15, pl. iii, fig. 2.

— — — *O. M. Reis.* Geognost. Jahresh. (1897), p. 108.

1901. — — *A. Wollemann.* Jahrb. d. k. preuss. geol. Landesanst., vol. xxi, p. 14.

— — — *H. Imkeller.* Palæontographica, vol. xlviii, p. 38.

1902. — — *J. P. J. Ravn.* Mollusk. i. Danmarks Kridtaflej. I. Lamellibr., p. 118.

1905. Exogyra lateralis, *T. Wegner*. Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 184.

? 1907. Gryphæostrea vomer, *S. Weller*. Cret. Pal. New Jersey, p. 455, pl. xliv, figs. 6—11.

1909. Ostrea (Exogyra) lateralis, *W. Rogala*. Bull. Internat. Acad. Sci. Cracovie (1909), 2, p. 691.

1911. Exogyra lateralis, *Fritsch*. Op. cit., Korycan. Schicht., p. 46, fig. 210.

— — — *K. Vogel von Falckenstein*. Zeitschr. d. deutsch. geol. Gesellsch., vol. lxii, p. 561.

Description.—Shell generally rather small, usually higher than long, very inequivalve.

Left valve very convex or inflated; the greatest convexity is between the umbo and the postero-ventral extremity, and gives in some cases the appearance of a much rounded carina, behind which the valve is either flattened or slightly concave; sometimes there is a posterior wing-like expansion. The ventral margin is rounded; the lower part of the posterior margin is often slightly concave, ending above in a point. Umbo usually much incurved, and directed posteriorly. The ligament pit usually curves posteriorly. This valve is attached posteriorly to the umbo; the size, shape, and direction of the attached surface vary in different individuals, and affect the form of the shell in the usual way. The surface of the shell shows growth-lines, and in some specimens there are numerous, fine, somewhat irregular ridges running parallel to the margin of the valve. In the interior of the valve a few widely separated growth-ridges occur.

Right valve operculiform, nearly flat, or concave or undulating. Umbo very small, curving spirally forwards. Surface with widely separated ridges running parallel to the margin of the valve.

Affinities.—The Albian and Cenomanian examples of this species were regarded by Coquand as distinct from those found in the Upper Chalk and named *O. lateralis* by Nilsson; but d'Orbigny, Geinitz, Peron, Jukes-Browne, and Hennig have shown that the forms named *lateralis* cannot be separated from those which occur in earlier beds (*canaliculata*). Peron states that on the Continent this species ranges without interruption through all the stages of the Cretaceous, from the Aptian to the Danian; he also notes its wide geographical distribution. This species belongs to Conrad's "genus" *Gryphæostrea*; it has been referred to *Gryphæa* by some writers, but more usually to *Exogyra*; the left valve, except for the attached surface, is often grypheate in form, while the right valve shows some resemblance to *Exogyra*. Pictet and Campiche consider that *O. canaliculata* is closely related to *Exogyra conica*; but it seems more probable that it is allied to

O. vesicularis, the differences being accounted for by the attached surface in the former being on the posterior side of the shell.

The form with well-developed concentric ridges (Plate LVI, fig. 10), which is abundant in the zone of *Actinocamax quadratus*, but ranges from the zone of *Rhynchonella Cuvieri* to that of *Belemnitella mucronata*, has been named *O. canaliculata* var. *striata*.[1]

Types.—*Chama canaliculata*, Sowerby, from the Upper Greensand of Shute, near Warminster, is in the British Museum. *O. lateralis*, Nilsson, is from the Upper Chalk of Sweden. *Chama conica*, Nilsson, from the Upper Chalk of Kopinge, Sweden. *Exogyra undata*, Sowerby, from the Upper Greensand, Blackdown, cannot be found.

Distribution.—Hythe Beds (Bargate Stone) of Godalming. Lower Greensand of Faringdon and Brickhill.

Gault of Folkestone and Okeford Fitzpaine. Upper Greensand (zones of *Schlœnbachia rostrata* and *Pecten asper*) of the Isle of Wight (Ventnor, Niton, Compton Bay). Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown. Upper Greensand (Rye Hill Sands) of Warminster.

Chalk Marl (zone of *Schlœnbachia varians*) of Chiseldon. Cenomanian of Wilmington, Devon. Zone of *Holaster subglobosus* of Fulbourn and Burwell.

Zone of *Rhynchonella Cuvieri* of Harvet (Kent). Melbourn Rock of Hitchin.

Zone of *Terebratulina lata* of Hampshire, the South Devon coast, and Dover.

Zone of *Holaster planus* of Culver Cliff and Dover.

Zone of *Micraster cor-testudinarium* of Pinhay, Borstal, Seaford and Dover.

Zone of *Micraster cor-anguinum* of Quidhamptom and Northfield.

Zone of *Marsupites testudinarius* of Taplow. *Uintacrinus* band of Devizes Road (Salisbury), Holmwood Park (Keston), and the Thanet Coast.

Zone of *Actinocamax quadratus* of East and West Harnham, Whaddon, Marwell (Hants), Compton, Shawford, Fareham, West Meon, Mottisfont, Taplow and Brighton.

Zone of *Belemnitella mucronata* of the Dorset Coast, Rogers Whiting Pit (Fareham) and Alderbury well.

Zone of *Ostrea lunata* of Trimingham.

OSTREA SEMIPLANA, *J. de C. Sowerby*, 1825. Plate LVI, figs. 17—19. Plate LVII, Plate LVIII, figs. 1—5. Text-figures 183—193).

1803. OSTRACITES SULCATUS, *J. F. Blumenbach*. Specim. archæol. tell., p. 18, pl. i, fig. 3. (Non. *Ostrea sulcata*, Born, 1778.)

[1] Rowe, 'Zones of the White Chalk. I, Kent and Sussex' (1900), p. 345; Griffith and Brydone, 'Zones of the Chalk in Hants' (1911), p. 3.

1822. Ostrea, *G. Mantell.* Foss. S. Downs, p. 207, pl. xxv, fig. 4.
1825. — semiplana, *J. de C. Sowerby.* Min. Conch., vol. v, p. 144. pl. cccclxxxix, fig. 3.
1827. — flabelliformis, *S. Nilsson.* Petrific. Suecana, p. 31, pl. vi, fig. 4.
— — ? plicata, *Nilsson.* Ibid., p. 31, pl. vii, fig. 12.
— — pusilla, *Nilsson.* Ibid., p. 32, pl. vii, fig. 11. (Non *pusilla*, Brocchi, 1814.)
1833. — alæformis, *S. Woodward.* Geol. Norfolk, p. 48, pl. vi, figs. 1—3.
— — inequicostata, *Woodward.* Ibid., p. 48, pl. vi, fig. 4.
— — flabelliformis, *A. Goldfuss.* Petref. Germ., vol. ii, p. 12, pl. lxxvi, fig. 1.
— — sulcata, *Goldfuss.* Ibid., p. 13, pl. lxxvi, fig. 2.
— — armata, *Goldfuss.* Ibid., p. 13, pl. lxxvi, fig. 3.
1837. — flabelliformis, *W. Hisinger.* Lethæa Suecica, p. 48, pl. xiv, fig. 1.
— — ? plicata, *Hisinger.* Ibid., p. 48, pl. xiv, fig. 2.
1837. — inconstans, *F. Dujardin.* Mém. Soc. géol. de France, vol. ii, p. 229.
1839. — flabelliformis, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 19.
1841. — — *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 45.
— — sulcata, *Römer.* Ibid., p. 46.
— — armata, *Römer.* Ibid., p. 46.
? 1843. — macroptera ? *H. B. Geinitz.* Die Verstein. von Kieslingswalda, p. 17, pl. iii, figs. 22—24.
— — sulcata, *Geinitz.* Ibid., p. 17.
1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 39, pl. xxviii, figs. 2—4, 8.
— — flabelliformis, *Reuss.* Ibid., p. 39, pl. xxviii, figs. 5—7, 16, pl. xxix, figs. 19, 20.
1847. — semiplana, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 747, pl. cccclxxxviii, figs. 4, 5.
— — flabelliformis, *J. Müller.* Petref. der Aachen. Kreidef., pt. 1, p. 39.
— — armata, *Müller.* Ibid., p. 39.
1849. — semiplana, *T. Brown.* Illustr. Foss. Conch. Gt. Britain and Ireland, p. 145, pl. lix, fig. 7.
— — inæquicostata, *Brown.* Ibid., p. 147, pl. lxi,*, fig. 13.
1850. — semiplana, *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 198.
— — carinata, *J. de C. Sowerby,* in *F. Dixon.* Geol. Sussex, p. 357 (*O. frons*, p. 386, ed. 2), pl. xxvii, fig. 2.
— — semiplana, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 256.

? 1850. Ostrea semiplana, *A. Alth.* Geogn.-paläont. Beschreib. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 254, pl. xiii, fig. 2.

1851. — Bronni, *J. Müller.* Petref. der Aachen. Kreidef., pt. 2, p. 69, pl. vi, fig. 20.

1854. — semiplana, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 174.

— — inæquicostata, *Morris.* Ibid., p. 173.

1859. — semiplana, *J. Müller.* Petref. der Aachen. Kreidef., Supplement, p. 7.

1863. — — *R. Drescher.* Zeitschr. der deutsch. geol. Gesellsch., vol. xv, p. 356.

— — sulcata, *A. Kunth.* Ibid., vol. xv, p. 732.

1868. — flabelliformis, *E. Eichwald.* Lethæa Rossica, vol. ii, p. 368.

1869. — semiplana, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 74, pl. xxviii, figs. 1—15; pl. xxxv, figs. 1, 2; pl. xxxviii, figs. 10—12.

— — cuculus, *Coquand.* Ibid., p. 52, pl. xvii, figs. 19—21.

— — licheniformis, *Coquand.* Ibid., p. 91, pl. xxxvii, figs. 17—19.

— — Merceyi, *Coquand.* Ibid., p. 93, pl. xxviii, fig. 22; pl. xxix, figs. 8—14.

— — Peroni, *Coquand.* Ibid., p. 95, pl. xxxv, figs. 3—5; pl. xxxviii, figs. 5—9.

— — acanthonota, *Coquand.* Ibid., p. 103, pl. xxxviii, figs. 1—4.

1870. — sulcata, *F. Römer.* Geol. v. Oberschles., p. 343, pl. xxix, fig. 3.

— — cuculus, *C. Schlüter.* Neues Jahrb. für Min., etc., p. 951.

1871. — semiplana, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 321.

1872 — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 29, pl. viii, figs. 8—11, 13.

1873. flabelliformis, *J. I. Lahusen.* Foss. White Chalk of Simbirsk (Imper. Russ. Min. Corps Instit.), pt. 2, p. 250, pl. v, fig. 3.

1876. (Alectryonia) sulcata, *D. Brauns.* Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 393.

1877. — semiplana, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat. ii, Weissenberg. u. Malnitz. Schicht., p. 141, fig. 138.

1878. — sulcata, *C. Barrois.* Ann. Soc. géol. Nord, vol. v, p. 408.

1882. Alectryonia sulcata, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 261.

? 1883. Ostrea semiplana, *Fritsch.* Op. cit., iii, Iserschicht., p. 121, fig. 97.

— — frons, *Fritsch.* Ibid., p. 121, fig. 96.

1885. — armata, *J. Böhm.* Verhandl. nat. Vereines preuss. Rheinl., vol. xlii, p. 76.

1885. Alectryonia crista ungulata, *Böhm*. Ibid., p. 75, pl. i, fig. 1.
1888. Ostrea semiplana, *A. Peron*. Hist. Terr. de Craie Bassin Anglo-Parisien, p. 179.
— — Peroni, *Peron*. Ibid., p. 180.
— — sulcata, *G. Müller*. Jahrb. d. k. preuss. geol. Landesanst. für 1887, p. 400.
1889. — semiplana, *E. Holzapfel*. Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 251, pl. xxviii, figs. 5, 6.
— Goldfussi, *Holzapfel*. Ibid., p. 249, pl. xxviii, figs. 8—18.
— — Bronni, *Holzapfel*. Ibid., p. 250, pl. xxviii, figs. 3—7.
— — armata, *Holzapfel*. Ibid., p. 253, pl. xxviii, figs. 1, 2.
— — Merceyi, *Holzapfel*. Ibid., p. 251, pl. xxviii, fig. 4.
? 1889. — semiplana, *Fritsch*. Op. cit., iv, Teplitz. Schicht., p. 87.
1889. — (Alectryonia) sulcata, *O. Griepenkerl*. Senon v. Königslutter (Palæont. Abhandl., vol. iv), p. 33.
1890—91. — semiplana, *A. Peron*. Descript. Brachiop., etc., Terr. Crét. Hauts-Plateaux de la Tunisie, p. 154.
? 1893. — — *Fritsch*. Op. cit., v, Priesener Schicht., p. 102.
1894. — — *B. Lundgren*. Mollusk. i *Mammillatus* och *Mucronata* zonerna (K. Svenska Vet.-Akad. Handl., n.f., vol. xxvi, No. 6), p. 37.
— larva, *Lundgren*. Ibid., p. 37.
— semiplana, *A. Hennig*. Geol. Fören. i Stockholm Förhandl., vol. xvi, p. 514.
— cuculus, *Hennig*. Ibid., p. 516.
1895. — Bronni, *F. Vogel*. Holländisch. Kreide, p. 7.
1897. — semiplana, *R. Leonhard*. Palæontographica, vol. xliv, p. 51.
? — — — *Fritsch*. Op. cit., vi, Chlomek. Schicht., p. 68.
— — — *A. Rutot*. Bull. Soc. Belge Géol. Pal. et Hydrol., vol. x, p. 25.
— — (Alectryonia) armata, *Rutot*. Ibid., p. 23.
— — semiplana, *A. Hennig*. Revision Lamellibr. i Nilsson's 'Petrific. Suecana,' p. 9, pl. i, figs. 7, 10—14, 16, 18, 19.
1898. — (Alectryonia) semiplana, *O. M. Reis*. Geognost. Jahresh. (1897), p. 107, pl. iv, fig. 18.
— semiplana, *G. Müller*. Molluskenfauna Untersen. v. Braunschweig u. Ilsede, p. 8, pl. i, figs. 1—4; pl. iii, figs. 3, 4.
1901. — — *A. Wollemann*. Jahrb. d. k. preuss. geol. Landesanst., vol. xxi (1900), p. 13.
— — — var. armata, *H. Imkeller*. Palæontographica, vol. xlviii, p. 37, pl. i, figs. 3—6.
? 1902. — cf. semiplana, *A. Wollemann*. Lüneburg. Kreide (Abhandl. d. k. preuss. geol. Landesanst., n. f., 37), p. 49.

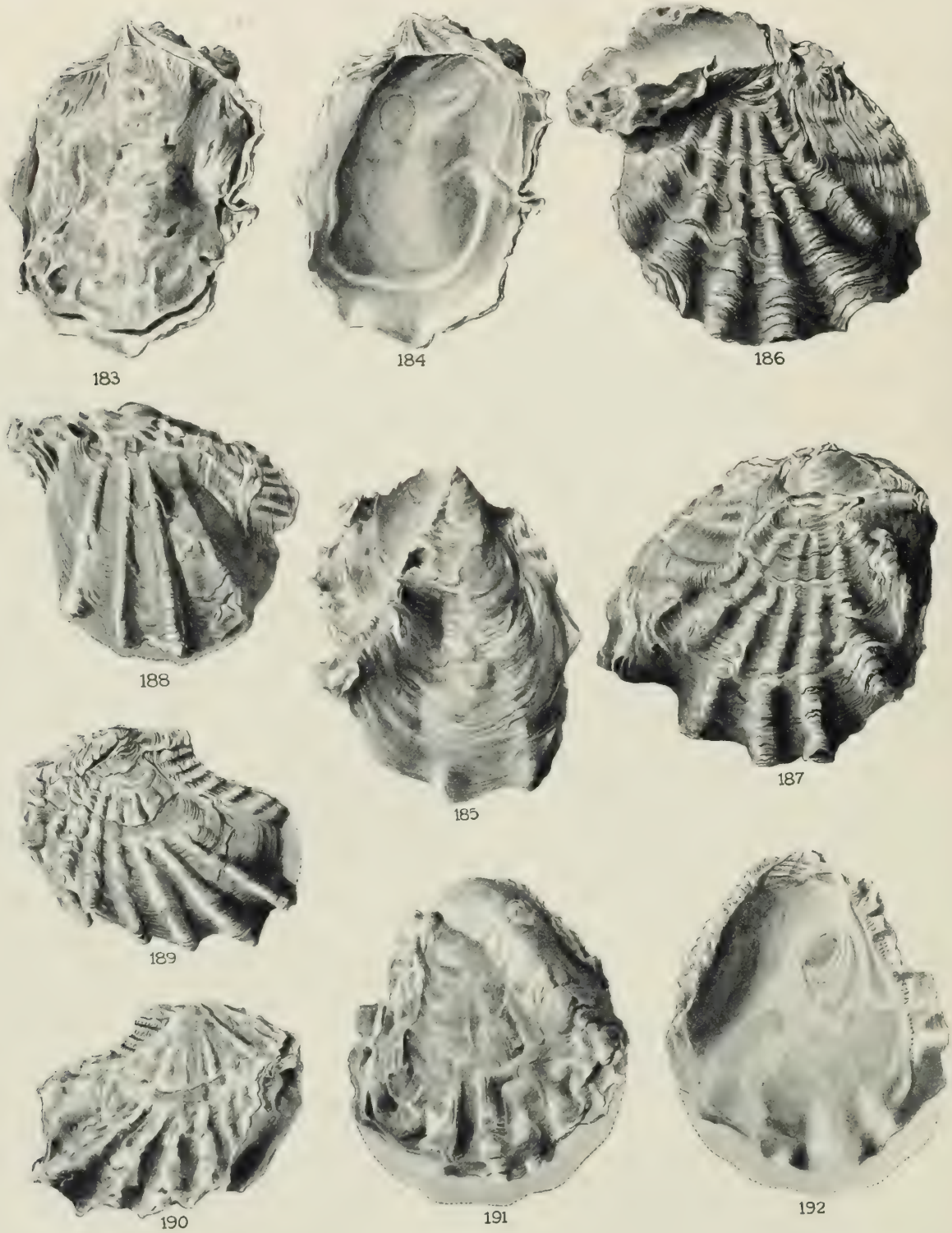
1902. Ostrea Merceyi, *Wollemann.* Ibid., p. 51, pl. iii, figs. 6, 7.
— — semiplana, *J. P. J. Ravn.* Mollusk. Danmarks Kridtafl. i, Lamellibr., p. 113, pl. iii, figs. 5, 7, 8.
1903. Alectryonia semiplana, *E. Dacqué.* Palæontographica, vol. xxx, 2, p. 366, pl. xxxiv, figs. 1—4.
1905. Ostrea semiplana, *T. Wegner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 177, fig. 10.
— — armata, *Wegner.* Ibid., p. 179, figs. 11—13.
? 1906. — — *L. Krumbeck.* Palæontographica, vol. liii, p. 93.
1908. — Peroni, *P. A. Peron.* Compte Rendu Assoc. Franç. Avanc. Sci., vol. xxxvi (1907), p. 307.
1909. — (Alectryonia) Peroni, *M. Leriche.* Ann. Soc. géol. Nord, vol. xxxviii, p. 67, pl. iii, figs. 20—27.
— — semiplana, *W. Rogala.* Bull. Internat. Acad. Sci. Cracovie (1909), 2, p. 690.
1911. — — *Fritsch.* Op. cit., Korycaner Schicht., p. 47, fig. 214.
1911. Alectryonia semiplana, *K. Vogel v. Falckenstein.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lxii, p. 559.

Description.—Form of shell extremely variable, depending on the shape, size and position of the surface to which the left valve is attached. In many specimens the shell was fixed to a cylindrical object (*Belemnitella*), but in other cases to a at or slightly curved surface.

In the larger, fully grown specimens, in which the attached surface is relatively small and mainly in front of the umbones, being either parallel or oblique to the hinge, the shell is more or less triangular, or four-sided, or rounded, and its height is then often greater than its length (Plate LVII, fig. 7 ; Text-figs. 183—192).

When the shell is attached to a cylindrical body the length of which is at right angles to the hinge-line, the height of the shell is, at any rate during the attached stage, much greater than its length, and the front and back margins are more or less nearly parallel (Plate LVII, figs. 8, 12), but subsequently the postero-ventral part may grow in a posterior direction (Plate LVII, fig. 11). When the length of the attached body is parallel or nearly parallel with the hinge-line, and posterior to the umbo, the shell becomes much longer than high and extremely inequilateral (Plate LVII, figs. 1—3). If the attached surface is directed obliquely backwards from the umbo the shell becomes oblique and inequilateral. In small specimens having a very small attached surface the shell becomes sickle-shaped and the two valves similar in form (Plate LVI, fig. 18).

During the period in which the left valve is attached to a cylindrical object the corresponding part of the right valve takes a similarly convex form and remains without folds; when the left valve is attached to a flat or slightly curved surface



Figs. 183—192.—*Ostrea semiplana*, Sowerby. 183—190, Zone of *Belemnitella mucronata*, Norwich. 183—185, right valve, and interior and exterior of left valve of one individual; Norwich Museum. 186, 187, left and right valves of one individual; Sedgwick Museum. 188, left valve (the right valve is concave); Sedgwick Museum. 189, 190, left and right valves of one individual; Norwich Museum, No. 2101. 191, 192. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. Exterior and interior of a right valve. All × $\frac{5}{6}$.

the corresponding part of the other valve is nearly flat and smooth (Plate LVIII, figs. 3—5). In the larger specimens with a relatively small attached surface the left valve (fig. 188) is more convex than the right, the latter becoming in some cases nearly flat or even concave. The free part of the shell develops folds. When the attached surface is relatively small the greater part of both valves possesses strong radial folds which interlock at the margin of the valves. The folds have more or less rounded summits, sometimes with small pointed projections, which occasionally develop into spines. The interspaces are usually broader than the folds. Well-marked growth-lines run parallel to the folded margin of the valves.

When only the margin of the shell is free no folds are developed, but the edge of the shell becomes toothed (Plate LVII, fig. 12); when a narrow strip is free numerous small folds appear on it (Plate LVII, fig. 13; Plate LVIII, figs. 1—4), forming a corrugated border to the smooth attached part of the shell. Occasionally, even when the greater part of the shell is free the folds are indistinct (figs. 183—185, 191). The direction of growth of the umbo, area, and ligament-pit vary according to the position of the attached surface; they may be in the plane of the valves, or curve inwards or outwards, sometimes becoming nearly perpendicular to the plane of the valves of the adult shell. The ligament-pit, area and umbones may be at right angles to the length of the shell, or may curve obliquely backwards or occasionally forwards. In some cases the area and ligament-pit are higher than long, in others longer than high.

The inner margin of the valves near the umbo often shows crenulations or minute irregular ridges. The form of the adductor impression varies with that of the shell; it is vertically elongated when the shell is high, and more rounded when the shell is longer.

Affinities.—A number of the different forms of this shell have been described as distinct species, since many writers have failed to recognise that the mode of growth of the shell is determined mainly by the character and position of the attached surface. The small sickle-shaped form (Plate LVI, fig. 18), with only a small surface of attachment and the two valves similar, was named *O. pusilla* by Nilsson (1827),[1] *O. alæformis* by Woodward (1833, pl. vi, fig. 1), and *O. Goldfussi* by Holzapfel (1889). Small forms which were attached for a longer period to a cylindrical object directed more or less nearly perpendicularly to the hinge (Plate LVII, figs. 8—11, Plate LVIII, figs. 1, 2) and with the margin of the valve folded and sometimes extended postero-ventrally were named *O. alæformis* by Woodward (1833, pl. vi, fig. 2), *O. Bronni* by Müller (1851),[2] *O. Peroni* by Coquand (1869). A form in which the shell was attached to a cylindrical object throughout except

[1] Hennig (1897), pl. i, figs. 14, 24.

[2] See also Hennig (1897), pl. i, figs. 7, 11, 12.

at the actual edge, which is toothed (Plate LVII, fig. 12), was named *O. Merceyi* by Coquand (1869).[1] Specimens which were attached to a flat object for a long period (Plate LVIII, figs. 3—5) were figured as *O. alæformis* by Woodward (1833, pl. vi, fig. 3) and *O. semiplana* by Sowerby (1825, the smaller figure). Larger forms with a relatively small portion of the anterior part of the shell attached to a cylindrical object and with well-developed folds, were named *O. inæquicostata* by Woodward (1833, pl. vi, fig. 4), *O. sulcata* by Nilsson (1827),[2] *O. flabelliformis* by Nilsson (1833),[3] and *O. semiplana* by Sowerby (1825, the larger figure) (Plate LVII, fig. 7; Text-figs. 186, 187, 193). The forms like *O. alæformis* and *O. Merceyi* are common in the upper zones. *O. carinata*, Sowerby (in Dixon, 1850), is a young form of *O. semiplana*. *O. armata*, Goldfuss, is recognised by Coquand and by Müller as a form of *O. semiplana* in which the ribs have become spiny. *O. licheniformis*, Coquand, is a form in which the valves have a rounded outline.

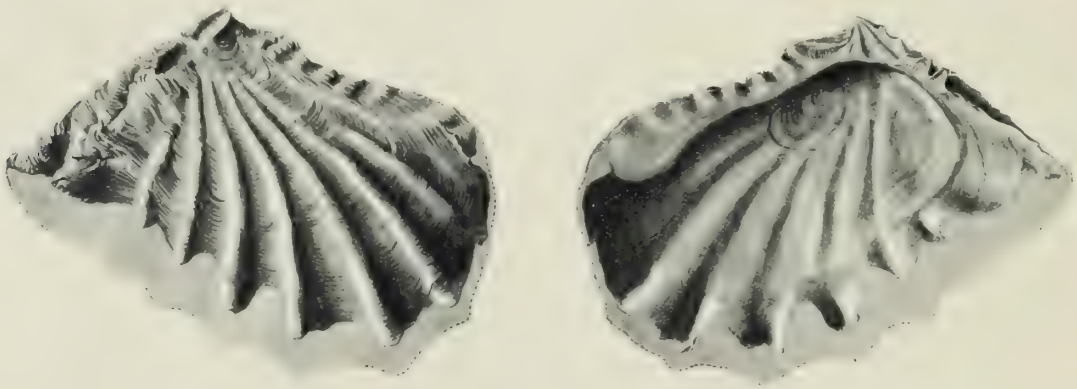


Fig. 193.—*Ostrea semiplana*, Sowerby. Zone of *Belemnitella mucronata*, Hartford Bridge, Norwich. Dr. Rowe's Collection. Exterior and interior of a left valve. × $\frac{5}{6}$.

O. acanthonota, Coquand, is a large form in which the ribs tend to become spiny. *O. arcotina*, Stoliczka, is closely allied to, and may be, as maintained by Peron, identical with *O. semiplana*. *O. Reboudi*, Coquand (= *O. plicatuloides*, Coq.) and *O. Janus*, Coquand, are regarded by Peron as forms of *O. semiplana*.

The close resemblance between the crenulations on the inner margin of the dorsal part of the valves in *O. semiplana* and in *O. vesicularis*, and the occasional presence of fine radial ribs on the right valve of *O. semiplana*, suggest that these two species are rather closely related.

Remarks.—The radial folds are usually stronger in examples from the zone of *Belemnitella mucronata* than in those from the lower zones. Occasionally the left umbo is exogyriform (Plate LVII, fig. 1 *b*), but this depends merely on the position of the attached surface.

[1] See also Holzapfel (1889) and Wollemann (1902).

[2] Hennig (1897), pl. i, fig. 18.

[3] Hennig (1897), pl. i, fig. 16.

Types.—*Ostracites sulcatus*, Blumenbach, from the Senonian of Salzberg near Quedlinburg, is stated by Hennig to be in the Natural History Museum, Berlin. *Ostrea* sp. Mantell, from the zone of *Micraster cor-anguinum* of Southerham near Lewes, and *O. semiplana*, Sowerby, from the zone of *Belemnitella mucronata* of Norwich, are in the British Museum. *O. alæformis*, Woodward, and *O. inequicostata*, Woodward, are from the zone of *B. mucronata* of Norwich; the original of fig. 3 of the former is in the Norwich Museum, but the other specimens cannot be found. *O. carinata*, Sowerby (in Dixon), cannot be found.

Distribution.—Probably zone of *Terebratulina lata* of the South Devon coast.

Zone of *Holaster planus* of the South Devon coast, Froxfield (Hants.), White Hill near Goring, and Hart's Lock Wood.

Zone of *Micraster cor-testudinarium* of Stevenage, Strood, and Chatham.

Zone of *Micraster cor-anguinum* of Micheldever, Witherington, Quidhampton, Foot's Cray, Southerham (Lewes), Northfleet, New Brompton, Gravesend, and Litcham, Norfolk.

Zone of *Marsupites testudinarius* of Ovingdean (Sussex). *Uintacrinus* band of Taplow and the Thanet coast.

Zone of *Actinocamax quadratus* of East Harnham.

Zone of *Belemnitella mucronata* of Ballard Head, Fareham, Clarendon and Norwich.

Zone of *Ostrea lunata* of Trimingham.

OSTREA SARUMENSIS, *sp. nov.* Plate LVIII, figs. 6—9.

Description.—Shell thick, higher than long; slightly, moderately, or considerable inequilateral.

Left valve very convex, with the attached surface of variable size. Area large, high, curved slightly or considerably backwards. Free part of valve with small radial folds, and growth-lamellæ. Inner margin with a row of small pits. Right valve slightly convex, with a large area; surface (except of the earlier part) ornamented with numerous small radial ribs separated by linear furrows, and crossed by growth-lamellæ.

Affinities.—The high area and the radial folds of the left valve suggest that this species may be related to *O. semiplana*; it also resembles some forms of *O. Boucheroni*. More specimens are needed in order to determine satisfactorily the affinities of this form.

Type.—In Dr. Blackmore's collection.

Distribution.—Zone of *Actinocamax quadratus* of East Harnham, near Salisbury.

OSTREA INCURVA, *Nilsson*, 1827. Plate LVIII, figs. 10—13. Plate LIX.

1827. OSTREA INCURVA, *S. Nilsson.* Petrif. Suecana, p. 30, pl. vii, fig. 6.
— — CURVIROSTRIS, *Nilsson.* Ibid., p. 30, pl. vi, fig. 5.
— — ACUTIROSTRIS, *Nilsson.* Ibid., p. 31, pl. vi, fig. 6.
1833. — CURVIROSTRIS, *A. Goldfuss.* Petref. Germ., vol. ii, p. 24, pl. lxxxii, fig. 2.
— — ACUTIROSTIS, *Goldfuss.* Ibid., p. 25, pl. lxxxii, fig. 3.
— — TRIANGULARIS, *S. Woodward.* Geol. Norfolk, p. 48, pl. vi, figs. 6, 7.
1837. — ACUTIROSTRIS, *W. Hisinger.* Lethæa Suecica, p. 47, pl. xiii, fig. 6.
— — CURVIROSTRIS, *Hisinger.* Ibid., p. 48, pl. xiii, fig. 7.
— — INCURVA, *Hisinger.* Ibid., p. 47, pl. xiii, fig. 5.
1847. — ACUTIROSTRIS, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 730, pl. cccclxxxi, figs. 1—3.
1849. — TRIANGULARIS, *T. Brown.* Illust. Foss. Conch. Gt. Britain and Ireland, p. 148, pl. lxi*, figs. 9, 10.
1850. — CURVIROSTRIS, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 255.
— — ACUTIROSTRIS, *d'Orbigny.* Ibid., p. 256.
— — CURVIROSTRIS, *A. Alth.* Geogn.-pal. Beschreib. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 254, pl. xii, fig. 38.
— ACUTIROSTRIS, *Alth.* Ibid., p. 254.
— — — , O. CURVIROSTRIS, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 173.
1859. — CURVIROSTRIS, *J. Müller.* Petref. Aachen. Kreideformat., Supplement, p. 7.
1868. — — *E. Eichwald.* Lethæa Rossica, vol. ii, p. 384.
1869. — — *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 67, pl. xxxv, figs. 16—22.
— ACUTIROSTRIS, *Coquand.* Ibid., p. 75, pl. xxxv, figs. 8—15, pl. xxxvi, figs. 1—5.
— — TRINACRIA, *Coquand.* Ibid., p. 64, pl. xxxv, figs. 23, 24.
? 1870. — ACUTIROSTRIS, *H. Credner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxii, p. 227.
1869. — CURVIROSTRIS, *E. Favre.* Moll. Craie de Lemberg., p. 162.
? 1871. — ACUTIROSTRIS, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 471, pl. xlv, figs. 1—6.
1878. CURVIROSTRIS, *G. Behrens.* Zeitschr. deutsch. geol. Gesellsch., vol. xxx, p. 260.
1881. — ACUTIROSTRIS, *R. Etheridge.* In Penning and Jukes-Browne, Geol. Cambridge, p. 146, pl. iii, figs. 5, 6.

1881. OSTREA ACUTIROSTRIS var. INFLEXA, *Etheridge.* Ibid., p. 146, pl. iii, figs. 7, 8.
1888. — CURVIROSTRIS, *A. Peron.* Hist. Terr. de Craie S.E. Bassin Anglo-Parisien, p. 173 (*partim*).
1889. — — *O. Griepenkerl.* Senon. v. Königslutter (Palæont. Abhandl., vol. iv), p. 34, pl. ii, fig. 1.
1891. — — *J. Böhm.* Palæontographica, vol. xxxviii, p. 92, pl. iv, fig. 5.
— — ACUTIROSTRIS, *Böhm.* Ibid., p. 92, pl. iv, fig. 11.
1894. — — *B. Lundgren.* Mollusk. i *mammillatus* och *mucronata* zonerna, p. 39.
— — CURVIROSTRIS, *Lundgren.* Ibid., p. 40.
— — SCANIENSIS, *Lundgren.* Ibid., p. 40.
— — CURVIROSTRIS, *A. Hennig.* Geol. Fören. i Stockholm Förhandl., vol. xvi, p. 514.
— — ACUTIROSTRIS, *Hennig.* Ibid., p. 514.
1895. — CURVIROSTRIS, *F. Vogel.* Holländisch. Kreide, p. 5.
— — ACUTIROSTRIS, *Vogel.* Ibid., p. 5.
— — SCANIENSIS, *Vogel.* Ibid., p. 6.
1897. — INCURVA, *A. Hennig.* Revis. Lamellibr. i Nilsson's "Petrif. Suecana," p. 11, pl. i, figs. 15, 17, 21—23, 25—28.
— — ACUTIROSTRIS, *F. Nötling.* U. Cret. (Maestrichtian) Mari Hills (Palæont. Indica, ser. xvi, vol. i), p. 37, pl. ix, figs. 1, 9.
1899. — — *G. de Alessandri.* Palæont. Italica, vol. iv, p. 198.
1901. — CURVIROSTRIS, *H. Imkeller.* Palæontographica, vol. xlviii, p. 37.
— — ACUTIROSTRIS, *Imkeller.* Ibid., p. 37.
? 1902. — — *A. Quaas.* Palæontographica, vol. xxx, 2, p. 184, pl. xxi, fig. 11.
— — — *E. Dacqué.* Ibid., p. 363.
— — INCURVA, *J. P. J. Ravn.* Mollusk. i Danmarks Kridtafl., I, Lamellibr. p. 112, pl. iii, fig. 4.
1906. — — *E. Böse.* Senon. Cárdenas (Bol. Inst. geol. México, No. 24), p. 42, pl. i, fig. 5.
1908. — CURVIROSTRIS, *A. Peron.* Compte Rendu Assoc. Franç. Avanc. Sciences, vol. xxxvi (1907), p. 306.
— — — *M. Leriche.* Ibid., p. 338 (*partim*).
1909. — INCURVA, *W. Rogala.* Bull. Internat. Acad. Sci. Cracovie (1909), 2, p. 691.

Description.—Shell thin, usually higher than long; its form very variable, depending on the character and size of the attached surface.

The left valve is flat when attached throughout to a flat surface; concave when attached to a convex surface; convex when attached to a concave surface or when attached to only a small object near the umbo; irregular when attached to an

irregular surface. When the marginal part is free it grows more or less nearly vertically upwards from the attached surface. When entirely fixed the valve may be nearly symmetrical, but has usually a posterior curvature; when attached by a small area it usually grows backwards and becomes more or less sickle-shaped. The ligament-pit and umbo are straight in the nearly symmetrical forms; in the curved forms they are bent or arched more or less considerably backwards, but occasionally forwards.

The right valve is slightly convex when the entire left valve is attached to a flat object; more convex when it is attached to a convex object; nearly flat when it is attached to a concave object or when attached near the umbo only; irregular and undulating when the attached surface is irregular. The outline of the valve and the curvature of the ligament-pit and umbo vary according to those of the left valve. The surface of the right valve sometimes shows concentric ridges, especially near the umbo, and when well preserved there are numerous, small, irregular, radiating ridges. The inner margin of the valve on each side of the umbo has small, transverse, somewhat irregular rounded ridges. The form of the adductor impression varies with the shape of the shell.

Affinities.—Hennig (1897) has shown clearly that the differences between Nilsson's *O. incurva*, *O. curvirostris* and *O. acutirostris* are due to the mode of growth, which is determined by the character and size of the attached surface; and for this species Hennig selects the name *O. incurva*.

O. triangularis, Woodward, which was named *O. trinacria* by Coquand, is a form in which the entire left valve is attached to a flat surface; in the type this valve is fixed to a small portion of a large *Inoceramus* (Plate LIX, fig. 14). *O. drepanon*, Wollemann,[1] closely resembles the forms like *O. triangularis*, and should probably be regarded as a synonym of *O. incurva*. *Gryphæa globosa*, Woodward,[2] is included in this species by Coquand, but in the absence of the type it is difficult to give a definite opinion. D'Orbigny and Peron also include *O. conirostris*, Goldfuss. Peron (1888, 1908) regards *O. Wegmanniana*, d'Orbigny, as a form of *O. incurva*. *O. subuncinella*, Böhm,[3] appears to be closely allied to *O. incurva*. *O. Rabelaisi*, Coquand,[4] from Meudon, resembles closely some forms of *O. incurva* (Plate LIX, figs. 12—14), and should probably be included in that species.

Some specimens of *O. incurva* resemble the early parts of *O. semiplana* before the development of the radial folds.

Types.—Nilsson's types came from the Upper Chalk of Sweden. *O. triangularis*,

[1] 'Lüneberger Kreide' (1902), p. 49, pl. vii, figs. 6, 7. Rogala, 'Bull. Internat. Acad. Sci. Cracovie' (1909), 2, p. 691, pl. xxviii, fig. 16.

[2] 'Geol. Norfolk' (1833), p. 52, pl. vi, fig. 8 (from Marham).

[3] 'Palæontographica,' vol. xxxviii (1891), p. 93, pl. iv, figs. 9, 10.

[4] 'Mon. Ostrea, Terr. Crét.' (1869), p. 66, pl. xxxvii, figs. 26, 27.

Woodward, from the zone of *Belemnitella mucronata* of Norwich, is in the Norwich Museum (Plate LIX, fig. 14).

Distribution.—Chalk Marl (zone of *Schlœnbachia varians*) of Burham and Dover.[1]

Totternhoe Stone (zone of *Holaster subglobosus*) of Burwell.

Zone of *Rhynchonella Cuvieri* of White Nothe (Dorset), Peter's Pit (Burham) and Dover.

Zone of *Terebratulina lata* of Branscombe, Warnford (Hants) and Beachy Head.

Zone of *Micraster cor-anguinum* of Quidhampton, New Brompton, and Grays.

Zone of *Marsupites testudinarius* of Devizes Road (Salisbury), Taplow and West Wickham. *Uintacrinus* band of the Thanet coast.

Zone of *Actinocamax quadratus* of East and West Harnham, West Meon, Mottisfont, Soberton and Winterbourne (Berks).

Zone of *Belemnitella mucronata* of Alderbury, Clarendon and Norwich.

Ostrea Boucheroni, *Coquand*, 1859. Plate LX, figs. 1—15.

1859.	Ostrea Boucheroni, *H. Coquand.*		Bull. Soc. géol. de France, ser. 2, vol. xvi, p. 1007.
1862.	—	tevesthensis, *Coquand.*	Géol. Pal. reg. sud. Province Constantine, p. 227, pl. xix, figs. 7—13.
1869.	—	Boucheroni, *Coquand.*	Mon. Ostrea, Terr. Crét., p. 85, pl. xxxi, figs. 1—3; pl. xxxvii, figs. 1—16; pl. xxxviii, fig. 20.
1890-1.	—	— *A. Peron.*	Descript. Brach., etc., Terr. Crét. Tunisie, p. 142.
1898.	—	— *G. Müller.*	Mollusk. Untersen. v. Braunschweig u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., n.f., 25), p. 11, pl. iii, figs. 5—9.

Description.—Shell variable in form, usually considerably higher than long, with the anterior and posterior margins generally diverging gradually from the umbo. Often the shell is more or less nearly symmetrical, but may be irregular, and with the ventral part expanded.

Left valve very convex, with the anterior and posterior parts sloping rapidly from the flank to the margin. The flank is flattened or moderately convex. Umbonal region usually narrow and pointed. The attached surface is at the umbo and is usually rather small but sometimes large; when large the height of the shell may be relatively small, and the form of the left valve more or less semi-cylindrical. In

[1] Specimens of *Ostrea* found in the Upper Greensand of Haldon resemble closely *O. incurva*.

the larger specimens a posterior wing-like part is developed, and may be separated from the remainder of the valve by a furrow. The surface is marked with growth-rings.

Right valve thin, slightly convex or nearly flat; umbo small, with the marginal part sometimes growing upwards at a considerable angle with the earlier part. Surface nearly smooth.

Affinities.—The English specimens agree closely with the figures given by Müller, and fairly well with some of the smaller examples figured by Coquand; but the larger forms, in which the height of the shell is relatively less, have not been found in this country.

Specimens in which the attached surface is larger than usual and the height of the shell relatively less (Plate LX, figs. 14, 15) resemble some forms of *O. vesicularis*, and there seems to be almost a complete passage between these two species; this resemblance has already been noticed by Peron in specimens found in the Lower Senonian of Tunis.

The right valve of small specimens is similar to that of the forms of *O. incurva* in which the posterior curvature of the umbo is slight.

The form from Tebessa (Constantine), named *O. tevesthensis* by Coquand, was subsequently identified by that author with *O. Boucheroni*, and that identification has been supported by Peron. *O. Rouvillei*, Coquand,[1] from Algeria, resembles the forms of *O. Boucheroni* which have a short and high shell.

Remarks.—In England the specimens now referred to *O. Boucheroni* have been hitherto identified as *O. Wegmanniana*, d'Orbigny,[2] but the latter species is regarded by Peron[3] and by Leriche,[4] as a synonym of *O. incurva* (p. 388). So far as I have been able to make out the characters of *O. Wegmanniana* from the figures of d'Orbigny and Coquand and from the examination of a single right valve, I am inclined to accept the view of Peron and Leriche.

This species is often gregarious; most of the English examples are of rather small size, and the left valve is much more frequently found than the right valve.

Type.—From the Lower Senonian of Lavalette (Charente), said to be in the École des Mines, Paris.

Distribution.—Zone of *Holaster planus* of Hitchin. Recorded by Rowe from the Isle of Wight.

Zone of *Micraster cor-anguinum* of Whitway (Hants), Farningham Road, Preston near Faversham, Gravesend, Charlton, and Loam Pit Hill (Lewisham).

[1] 'Geol. Pal. reg. sud. Province Constantine' (1862), p. 232, pl. xxii, figs. 9—10; and 'Mon. Ostrea, Terr. Crét.' (1869), p. 89, pl. xxi, figs. 3—6, pl. xxiv, figs. 7—11.

[2] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 749, pl. cccclxxxviii, figs. 6—8. Coquand, op. cit. (1869), p. 53, pl. iv, figs. 9—11, pl. xxiii, figs. 11—14. Alessandri, 'Pal. Italica,' vol. iv (1899), p. 198.

[3] 'Hist. Terr. Craie, S.E. Bassin Anglo-Parisien' (1888), p. 173.

[4] 'Compte Rendu Assoc. Franç. Av. Sci.,' 1907, pt. 2 (1908), p. 338.

Zone of *Marsupites testudinarius* of Farnborough, Ropley, Taplow, and Brighton. Recorded by Rowe from the Sussex and Thanet coasts.

Uintacrinus band of Devizes Road (Salisbury); Odeham, Alresford, and Itchen Abbas (Hants); Margate.

Zone of *Actinocamax quadratus* of Bullington, Ropley, Wield, Andover, and Rottingdean.

OSTREA LUNATA, *Nilsson*, 1827. Plate LX, figs. 16—19. Plate LXI, figs. 1—6.

1816.	OSTREA CANALICULATA, *J. Sowerby.*	Min. Conch., vol. ii, p. 81, pl. cxxxv, fig. 1. (Non *canaliculata*, Sowerby, 1813).
1827.	— LUNATA, *S. Nilsson.*	Petrif. Suecana, p. 31, pl. vi, fig. 3.
1833.	— — *A. Goldfuss.*	Petref. Germ., vol. ii, p. 11, pl. lxxv, fig. 2.
1834.	— NASUTA, *S. G. Morton.*	Synop. Org. Remains Cret. U. States, p. 51, pl. ix, fig. 6.
? —	— MESENTERICA, *Morton.*	Ibid., p. 51, pl. ix, fig. 7.
1837.	— LUNATA, *W. Hisinger.*	Lethæa Suecica, p. 49, pl. xiv, fig. 4.
1849.	— — *T. Brown.*	Illustr. Foss. Conch. Gt. Britain and Ireland, p. 147, pl. lxi*, figs. 20, 21.
1854.	— LARVA, *J. Morris.*	Cat. Brit. Foss., ed. 2, p. 173.
1869.	— UNGULATA, *H. Coquand.*	Mon. Ostrea, Terr. Crét., p. 58 (*partim*), pl. xxxi, figs. 6—8 (? 9, 10).
? 1870.	— LUNATA, *H. Credner.*	Zeitschr. d. deutsch. geol. Gesellsch, vol. xxii, p. 227.
1884.	— (ALECTRYONIA) LARVA, *C. A. White.*	Ostreidæ of N. America (4th Ann. Rep. U.S. Geol. Survey), p. 296, pl. xlii, figs. 2—5, ? 6 (not 7—9).
1885.	— LARVA var. NASUTA, *R. P. Whitfield.*	Brach. and Lamellibr. Raritan Clays (Mon. U.S. Geol. Surv., vol. ix), p. 34, pl. iii, figs. 3, 4.
1894.	— LUNATA, *A. Hennig.*	Geol. Fören. i Stockholm Förhandl., vol. xvi, p. 515.
1895.	— (ALECTRYONIA) LUNATA, *F. Vogel.*	Holländisch. Kreide, p. 10.
1897.	— LUNATA, *A. Hennig.*	Revis. Lamellibr. i Nilsson's "Petrific. Suecana," p. 14.
1907.	— NASUTA, *S. Weller.*	Cret. Pal. New Jersey, p. 447, pl. xliii, figs. 7, 8.
? —	— MESENTERICA, *Weller.*	Ibid., p. 446, pl. xliii, figs. 9—14.

Description.—Shell inequivalve, elongated between the umbo and the posterior extremity, curved regularly, usually sickle-shaped.

Left valve moderately or slightly convex, the part near the umbo being more convex than the later part. Umbo small, usually curved posteriorly, with, in nearly

all cases, a very minute surface of attachment; on each side of the umbo is a wing-like or ear-like extension. The early part of the shell is smooth except for concentric lines or ridges and occasionally fine radial furrows; in the adult the anterior and ventral marginal parts develop broad rounded folds. The stage at which the folding begins and the size and number of the folds, vary in different individuals. Small folds sometimes occur on the posterior wing-like part. The ligament-pit is sometimes straight but usually curves posteriorly.

Right valve at first smooth and nearly flat, occasionally slightly concave, but afterwards becoming folded like the left valve. Umbo very small.

Affinities.—Most writers, following the example of Coquand, have united *O. lunata*, Nilsson, with *O. ungulata* (Schlotheim),[1] regarding the former as a young stage of the latter. Hennig (1894, 1897) and Vogel (1895), however, do not

[1] Knorr, 'Recueil. Monum. Castast. Pétrificat.,' vol. ii (1768), p. 130, P. II, pl. Dvii, figs. 5, 6. Bruguière, 'Hist. nat. Vers et Mollusques (Encycl. méthod.), Planches,' vol. iv (1827), pl. clxxxviii, figs. 4, 5. Faujas-St.-Fond, 'Hist. nat. Mte. Ste. Pierre' (1799), p. 150, pl. xxiii, fig. 6. *Ostracites ungulatus*, v. Schlotheim, in Leonhard's 'Taschenb. für Min.,' vol. vii, pt. 1 (1813), p. 112; *O. crista meleagris*, Schlothem, ibid., p. 112. *O. larva*, Lamarck, 'Animaux sans Vert.,' vol. vi (1819), p. 216; *O. doridella*, Lamarck, ibid., p. 210. ? *O. falcata*, Morton, 'Amer. Journ. Sci.,' vol. xvii (1830), p. 284; vol. xviii (1830), pl. iii, figs. 19, 20. *O. larva*, Goldfuss, 'Petref. Germ.,' vol. ii (1833), p. 10, pl. lxxv, fig. 1. ? *O. falcata*, Morton, 'Synop. Org. Rem. Cret. U. States' (1834), p. 50, pl. iii, fig. 5. *Alectryonia acrodonte*, Fischer de Waldheim, 'Bull. Soc. Imp. Nat. Moscou,' vol. viii (1834—5), p. 116, pl. v, fig. 2. *O. larva*, d'Orbigny, 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 740, pl. cccclxxxvi, figs. 4, 5, 8 (? 6, 7). *O. larva*, Müller, 'Petref. der Aachen. Kreidef.,' pt. 1 (1847), p. 39. *O. tegulanea*, Forbes, 'Trans. Geol. Soc.,' ser. 2, vol. vii (1846), p. 156, pl. xviii, fig. 6. *O. ponticeriana*, d'Orbigny, 'Voy. Pol. Sud et l'Océanie. Atlas Géol.' (1847), pl. viii, figs. 45, 46. ? *O. larva* ?, Kner, 'Kreidemerg. v. Lemberg' (1850), p. 30, pl. v, fig. 4. *O. urogalli*, Quenstedt, 'Handb. d. Petrefactenkunde' (1852), p. 499, pl. xl, fig. 24. *O. larva*, Beyrich, 'Zeitschr. deutsch. geol. Gesellsch.,' vol. iv (1852), p. 153, pl. iv, fig. 3. ? *O. frons*, Kner, 'Denkschr. Akad. Wiss. Wien, Math.-nat. Cl.,' vol. iii (1852), p. 319, pl. xvii, fig. 10. ? *O. larva*, Favre, 'Moll. Foss. de la Craie de Lemberg' (1869), p. 160. *O. ungulata*, Coquand, 'Mon. Ostrea, Terr. Crét.' (1869), p. 58 (*partim*), pl. xxxi, figs. 4, 5, 12—15. *O.* (*Alectryonia*) *ungulata*, Stoliczka, 'Cret. Fauna S. India,' vol. iii (1871), p. 470, pl. xlvii, figs. 3, 4. *O. larva*, Lartet, 'Ann. Sci. géol.,' vol. iii (1873), p. 59. *Alectryonia larva*, Schröder, 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. xxxiv (1882), p. 262. *O.* (*Alectryonia*) *larva*, White, 'Ostreidæ of N. America' (1884), p. 296, pl. xlii, figs. 7—9. *O. ungulata*, Peron, 'Hist. Terr. de Craie S.E. Bassin Anglo-Parisien' (1888), p. 178. *O.* (*Alectryonia*) *larva*, Griepenkerl, 'Senon. v. Königslutter' ('Palæont. Abhandl.,' vol. iv, 1889), p. 33. *O. ungulata*, Holzapfel, 'Mollusk. Aachen. Kreide' ('Palæontographica,' vol. xxxv, 1889), p. 250. *Alectryonia ungulata*, Newton, 'Quart. Journ. Geol. Soc.,' vol. xlv (1889), p. 333, pl. xiv, fig. 12. *O. ungulata*, Peron, 'Descript. Brach., etc., Terr. Crét. Tunisie' (1890—91), p. 185. *O. ungulata*, Böhm, 'Palæontographica,' vol. xxxviii (1891), p. 91. *A. ungulata*, Newton, 'Journ. Conch.,' vol. viii (1896), p. 136. *O.* (*Alectryonia*) *ungulata*, Nötling, 'U. Cret. (Mæstrichtian) Mari Hills' ('Palæont. Indica,' ser. xvi, vol. i, 1897), p. 38, pl ix, figs. 4, 5. ? *O.* cf. *larva*, Quaas, 'Palæontographica,' vol. xxx, 2 (1902), p. 187, pl. xxi, fig. 12. *O.* (*Alectryonia*) *ungulata*, Boule and Thevenin, 'Annal. Paléont.,' vol. i (1906), p. 48 [6], pl. i, fig. 5. *A. larva*, Krumbeck, 'Palæontographica,' vol. liii (1906), p. 96, pl. vii, fig. 10. *O.* (*Alectryonia*) *ungulata*, Pethö, ibid., vol. lii (1906), p. 185, pl. xii, fig. 1.

accept this view, and consider that *O. lunata* is a distinct species. They have studied a large series of specimens agreeing with Nilsson's type, and do not find any transitions between *O. lunata* and *O. ungulata*. After examining a large number of specimens of *O. lunata* from Trimingham and comparing them with foreign examples and figures of *O. ungulata*, I am led to accept the conclusions of Hennig and Vogel. From the character of the margin of the shell these specimens appear to be fully grown individuals and they are not associated with any examples agreeing with Schlotheim's species. In *O. ungulata* the early part of the shell resembles the adult of *O. lunata*, but subsequently it becomes more elongate and develops much deeper folds on the posterior as well as on the anterior margin, consequently the valves become much deeper and more nearly equal than in *O. lunata*. Since the folding starts at a later stage in *O. lunata* than in *O. ungulata*, it is difficult to see how individuals of the former could ever develop into the latter as has been supposed by some writers.

Some of the small, sickle-shaped forms of *O. semiplana* show some resemblance to *O. lunata*, but their attached surface is usually larger and their folds are smaller and more numerous and occur on the posterior as well as the anterior margin.

Remarks.—Mr. Brydone has found a few examples of *O. lunata* in which the left valve is entirely attached to the surface of echinoids.

Types.—*O. canaliculata*, Sowerby, from Trimingham, is in the British Museum. *O. lunata*, Nilsson, is from the Ähus-sandstone. Hennig states that the figure given by Nilsson does not correctly represent the folds.

Distribution.—Upper Chalk (zone of *Ostrea lunata*) of Trimingham, Norfolk.

Genus—EXOGYRA, *T. Say*, 1820.
('Amer. Journ. Sci.,' vol. ii, p. 43).

EXOGYRA SINUATA (*Sowerby*), 1822. Plate LXI, fig. 13. Text-figs. 194—214.

1821.	GRYPHÆA	COULONI, *M. J. L. Defrance.*	Dict. Sci. nat., vol. xix, p. 534.
—	—	DUMERILII, *Defrance.*	Ibid., p. 535.
1822.	—	SINUATA, *J. Sowerby.*	Min. Conch., vol. iv, p. 43, pl. cccxxxvi (non *Ostrea sinuata*, Lamarck, 1819).
—	—	AQUILA, *A. Brongniart.*	In Cuvier's Ossem. Foss., vol. ii, pp. 332, 614, pl. ix, fig. 11.
1829.	—	SINUATA, *J. Phillips.*	Geol. Yorks., p. 122, pl. ii, fig. 23.
—	EXOGYRA	LÆVIGATA, *Sowerby.*	Min. Conch., vol. vi, p. 220, pl. dcv, fig. 4.
1833.	—	AQUILA, *A. Goldfuss.*	Petref. Germ., vol. ii, p. 36, pl. lxxxvii, fig. 3.

1836. Ostrea falciformis, *F. A. Römer.* Die Verstein. nord-deutsch. Ool.-Geb., p. 59.
1837. Amphidonte aquila, *G. G. Pusch.* Polens Paläont., p. 38.
1840. Exogyra sinuata, *A. Leymerie.* Bull. Soc. géol. de France, vol. xi, p. 121 (vars. *subsinuata*, etc., p. 124).
1841. — — *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 47.
? — — undata, *Römer.* Ibid., p. 47.
1842. — sinuata et subsinuata *A. Leymerie.* Mém. Soc. géol. de France, vol. v, pp. 16, 17, 28, pl. xii.
1845. Gryphæa sinuata *vars.* lævigata, subsinuata, Couloni, *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 250.
1846. Exogyra sinuata, *A. Leymerie.* Statist. géol. et min. de l'Aube, pl. vi, fig. 1.
— — subsinuata, *Leymerie.* Ibid., pl. vii, fig. 3.
— — — *var.* aquilina, *Leymerie.* Ibid., pl. vii, fig. 4.
1847. Ostrea Couloni, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 698, pl. cccclxvi, figs. 1—4; pl. cccclxvii, figs. 1—3.
— — aquila, *A. d'Orbigny.* Ibid., p. 706, pl. cccclxx, figs. 1—4.
? — Exogyra sinuata, *A. d'Archiac.* Mém. Soc. géol. de France, ser. 2, vol. ii, p. 313.
1849. Gryphæa sinuata, *T. Brown.* Illustr. Foss. Conch. Gt. Brit. and Ireland, p. 149, pl. lx, fig. 5.
— — aquila, *Brown.* Ibid., p. 150, pl. lxi*, figs. 17—19.
— — lævigata, *Brown.* Ibid., p. 149, pl. lx, fig. 17.
1850. Exogyra aquila, *J. Ewald.* Zeitschr. d. deutsch. geol. Gesellsch., vol. ii, p. 470.
1853. Ostrea aquila, *F. J. Pictet and W. Roux.* Moll. Foss. Grès verts de Genève, p. 520, pl. xlviii, figs. 1, 2.
1854. Exogyra sinuata, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 167.
1855. Ostrea Couloni, *G. Cotteau.* Moll. Foss. de l'Yonne, p. 122.
— — aquila, *Cotteau,* Ibid., p. 122.
1858. — Couloni, *F. J. Pictet and E. Renevier.* Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 138.
1859. — — *J. Vilanova-y-Piera.* Mem. geog.-agric. de Castellon, pl. iii, fig. 24.
1861. — — *P. de Loriol.* Anim. Invert. Foss. Mt. Salève, p. 110.
1868. — — *de Loriol.* Valangin. d'Arzier (Vaud). (Matér. Pal. Suisse, ser. 4), p. 51.
— Exogyra aquila, *E. Eichwald.* Lethæa Rossica, vol. ii, p. 399.
1869. Ostrea Couloni, *P. de Loriol and V. Gilliéron.* Urgon. infér. de Landeron, p. 24.
— — aquila, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 158, pl. lxi, figs. 4—9.

1869. Ostrea Couloni, *Coquand.* Ibid., p. 180, pl. lxv, fig. 10 ; pl. lxxi, figs. 8—10 ; pl. lxxiv, figs. 1—5; pl. lxxv, figs. 1—6, 22.

1870. — — *L. Dieulafait.* Bull. Soc. géol. France, ser. 2, vol. xxvii, p. 431.

1871. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 287, pls. clxxxvii, clxxxviii, cxcii, fig. 1.

1875. Exogyra sinuata, *J. Phillips.* Geol. Yorks., Part i, ed. 3, p. 244, pl. ii, fig. 23.

— — subsinuata, *Phillips.* Ibid., p. 244.

1877. Ostrea Couloni, *G. Böhm.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxix, p. 231.

1878. Ætostreon latissimum, *E. Bayle.* Explic. Carte géol. France, vol. iv, pt. 2, Atlas, pl. cxxxix, figs. 1—3.

— — consobrinus, *Bayle.* Ibid., pl. cxxxix, fig. 4.

— — Couloni, *Bayle.* Ibid., pl. cxl, figs. 1, 2.

— — aquilinum, *Bayle.* Ibid., pl. cxl, figs. 3—5.

? 1883. Ostrea (Exogyra) Couloni, *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 100.

1884. — — — *O. Weerth.* Fauna d. Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 55.

1884. Exogyra aquila, *C. A. White.* Foss. Ostreidæ of N. America (4th Ann. Rep. U.S. Geol. Surv.), p. 304, pl. liii, figs. 1, 2.

1886. — Couloni, *H. Trautschold.* Nouv. Mém. Soc. Imp. Nat. Moscou, vol. xv, p. 133.

1889. sinuata, *G. W. Lamplugh.* Quart. Journ. Geol. Soc., vol. xlv, p. 615.

1891. — Couloni, *O. Behrendsen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xliii, p. 419.

1895. Ostrea (Exogyra) Couloni, *G. Maas.* Ibid., vol. xlvii, p. 270.

1896. Exogyra Couloni, *A. Wollemann.* Ibid., vol. xlviii, p. 831.

1897. — sinuata, *R. B. Newton.* Proc. Dorset Nat. Hist. and Antiq. Field Club, vol. xviii, p. 74, pl. ii, figs. 2, 3.

? 1897. — aquila, *K. Gerhardt.* Neues Jahrb. für Min., etc., Beil.-Bd. xi, p. 175, pl. iv, fig. 10.

1900. — Couloni, *A. Wollemann.* Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preus. geol. Landesanst. N.F., pt. 31), p. 8, pl. i, fig. 1.

? 1903. — *cf.* Couloni, *W. Paulcke.* Neues Jahrb. für Min., etc., Beil.-Bd. xvii, p. 291.

? 1904. — Couloni, *E. Dacqué.* Beitr. Paläont. u. Geol. Österr.-Ungarns u. d. Orients, vol. xvii, p. 14, pl. ii, figs. 6—8.

1905. Exogyra Couloni, *E. Harbort.* Fauna d. Schaumburg - Lippe'schen Kreidemulde (Abhandl. d. k. preuss. geol. Landesanst., N.F., 45), p. 30.

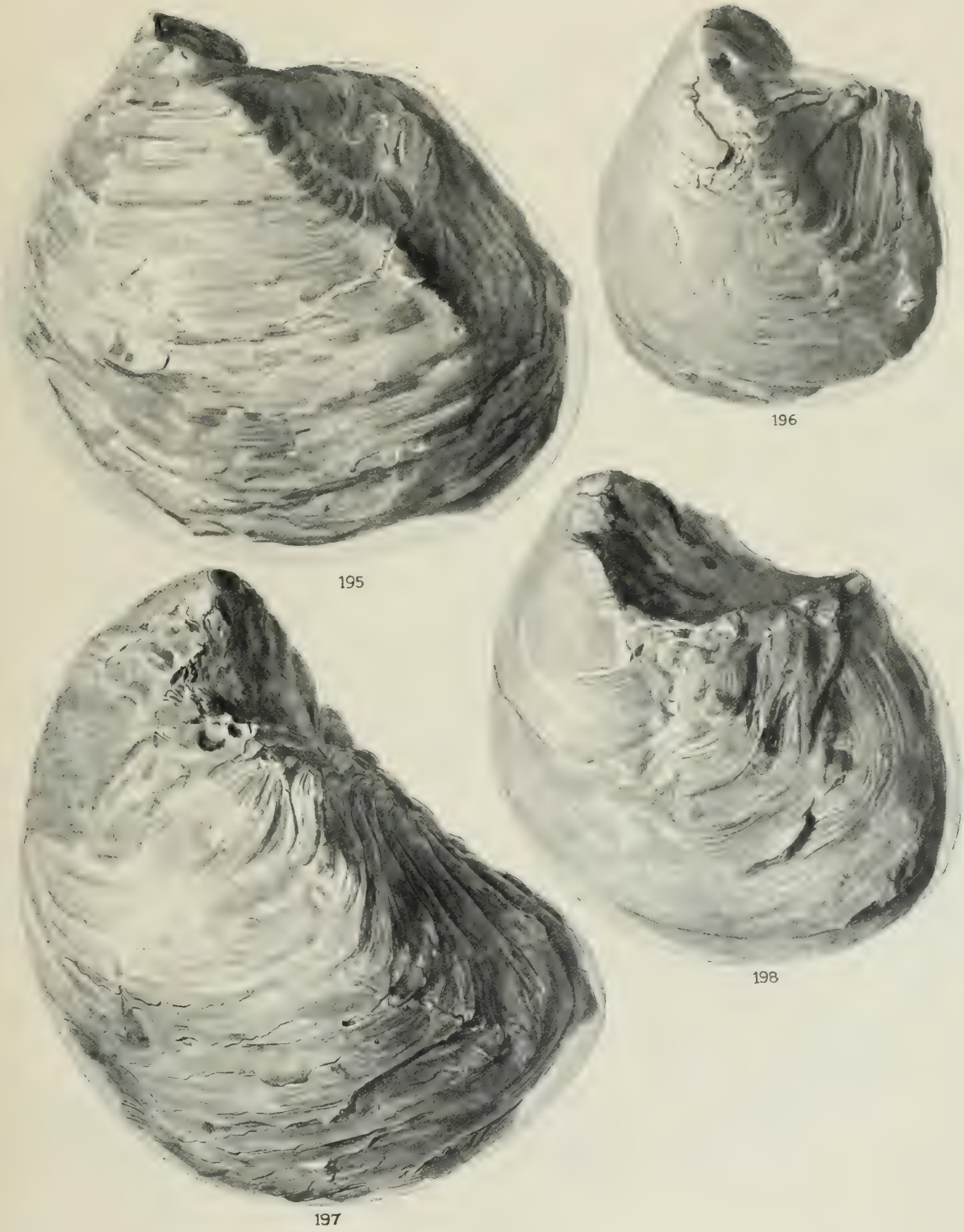
1907. — — *O. Haupt.* Neues Jahrb. für Min., etc., Beil.-Bd. xxiii, p. 211.

1908. — — *A. A. Stojanoff.* Ann. géol. et min. Russie, vol. x, p. 119.

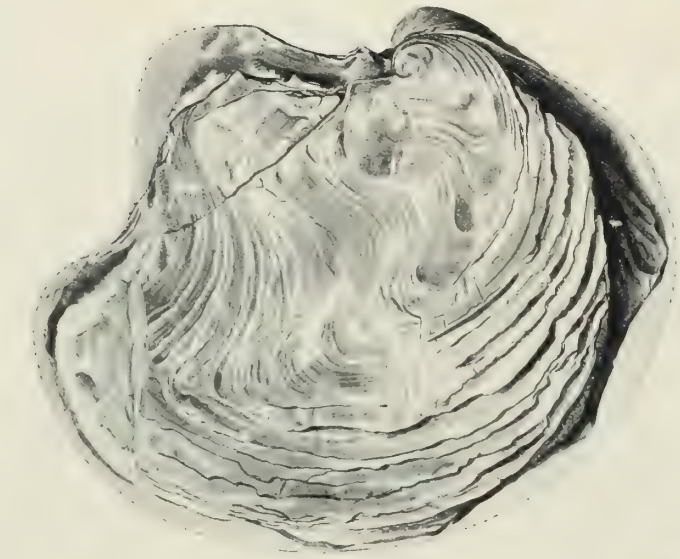
Fig. 194.—*Exogyra sinuata* (Sow.) Hythe Beds, Sevenoaks. Sedgwick Museum, Cambridge. Left valve. × ¾.

Description.—Shell with subtrigonal, subquadrate, oval or rounded outline; often large and massive. The posterior margin is truncated; in the early stages of growth it is either nearly straight or slightly concave; later it becomes more concave, with an angular projection at its dorsal and at its ventral end; in large specimens this margin usually becomes more rounded. The anterior and ventral margins usually form a convex curve. In large specimens the postero-dorsal margin is sometimes nearly straight. In many small, and in some large specimens, the height of the shell is distinctly greater than the length, but in others, particularly large forms, the height and length are nearly equal. In some of the high forms the shell is considerably arched, the posterior part being concave.

Left valve moderately or very convex. Umbo often relatively small, usually spiral, with a moderate or large backward curvature. The surface of attachment is



FIGS. 195—198.—*Exogyra sinuata* (Sow.). Left valves. 195, 197, 198, Sedgwick Museum. 196, Mr. Lamplugh's Collection. 195, Hythe Beds, Hythe. 196, Speeton Clay (zone of *Belemnites lateralis*), Speeton. 197, Tealby Limestone, Claxby. 198. Ferruginous Sands, Atherfield. All × $\frac{3}{4}$.



199

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202

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FIGS. 199—203.—*Exogyra sinuata* (Sow.). Sedgwick Museum. 199, 200, right and left valves of one specimen; Lower Greensand, Atherfield. 201—203, left valves. 201, 202, Tealby Limestone, Claxby. 203, Claxby Ironstone, Donnington. All × $\frac{3}{4}$.

behind the umbo and is usually of small or moderate size. A carina extends in a curve from the umbo towards the postero-ventral extremity, and sometimes bears coarse tubercles or spiny projections; it is at first strong, and may be continued to the postero-ventral margin of the valve, which is then angular; but in large specimens it often becomes indistinct during the later stages of growth and may ultimately disappear. Usually the carina is angular at first and becomes rounded later, but it may be angular throughout or rounded throughout; sometimes it divides the valve into two nearly equal parts, but usually the anterior is larger than the posterior part. The former is convex; the latter is flattened or concave or undulating, and its slope to the posterior margin is often gradual, but may be steep or even perpendicular. The surface of the valve bears distinct growth-lines, and sometimes shows faint radial folds. The curvature of the ligament-pit varies with that of the umbo.

Right valve usually nearly flat or slightly concave or undulating, but sometimes very concave. Its outline varies as in the left valve. Umbo small, more or less considerably spiral. Surface with growth-lines and occasionally with faint radial ribs. Adductor impression large, oval, usually sub-median.

Affinities.—By some authors, especially Leymerie and Coquand, the forms similar to the types of *Gryphæa sinuata*, Sowerby, and *G. aquila*, Brongniart,[1] have been regarded as specifically distinct from those like *Exogyra subsinuata*, Leymerie[2]; but Pictet and Renevier (1858), after studying a large series of specimens from Switzerland, France, and England, came to the conclusion that it was impossible to separate these as two species; the same view was maintained by Pictet and Campiche in 1871, and has been supported more recently by Wollemann (1900), who has examined a large series of specimens from North Germany. Pictet, Renevier and Campiche showed that the two forms are not, as Leymerie maintained, characteristic of different horizons, but occur together, although varying in abundance at different levels. The study of numerous English and some foreign specimens leads me to endorse the view first expressed by Pictet and Renevier. The variation is found to be extremely great, and the different forms are connected by numerous gradations. It is also noticeable, as Pictet and Renevier pointed out, that the varieties of *subsinuata*, some of which were named *aquilina*, *dorsata*, and *falcifera* by Leymerie, may differ from one another more than they do from *sinuata*. The forms of the *sinuata* (*aquila*) type are common in the Atherfield and Hythe Beds, and those of the *subsinuata* type occur mainly in the zones of *Belemnites lateralis* and *B. jaculum*, but neither is confined to those horizons.

[1] See figs. 194, 195, 199, and the figures of Sowerby (1822), Brongniart (1822), Pictet and Roux (1853), Leymerie (1846), pl. vi, fig. 1.

[2] See figs. 202, 203, 206, 212, 214, and Leymerie (1842), pl. xii, figs. 3, 7; (1846), pl. vii, figs. 3, 4.

FIGS. 204—213.—*Exogyra sinuata* (Sow). 204, 205, left and right valves of one individual; Hythe Beds, Hythe; Sedgwick Museum. 206, 207, 210, Claxby Ironstone, Donnington; Sedgwick Museum; 206, 210, left valves; 207, right valve of 206. 208, 209, Hythe Beds, Hythe. Museum of Practical Geology, No. 20821. Left and right valves (*lævigata* form). 211, Speeton Clay, (zone of *B. lateralis*), Speeton. Mr. Lamplugh's Collection. Left valve. 212, 213. Speeton Clay, Speeton. Sedgwick Museum. Left and right valves of one individual. All × $\frac{5}{6}$.

Exogyra imbricata, Krauss,[1] from the Uitenhage Series, is closely allied to *E. Couloni*.

Remarks.—The proportion of the height to the length of the shell varies considerably. In some specimens the height is much greater than the length, but in others the two diameters are nearly equal. In the latter case the left valve is usually less convex relatively than in the higher and more strongly carinate forms. In the specimens in which the carina reaches the margin the postero-ventral extremity is more angular than in those in which it becomes indistinct. The slope of the posterior part of the left valve is gentle in the forms in which the height and length are nearly equal, but becomes steeper in the higher and more strongly carinate forms,

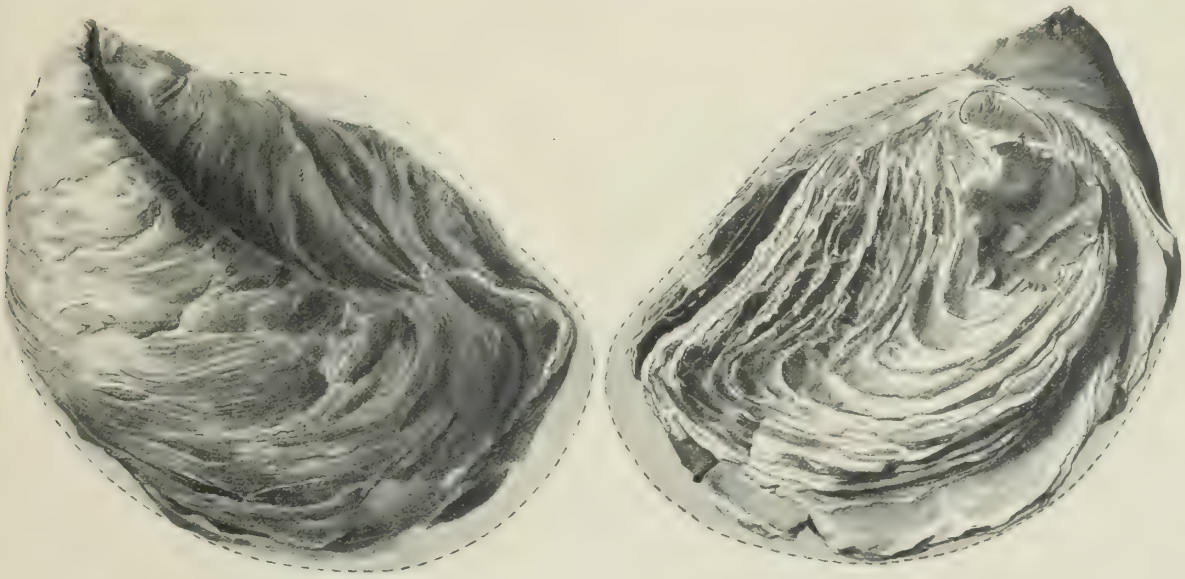


Fig. 214.—*Exogyra sinuata* (Sow). Speeton Clay (probably zone of *Belemnites lateralis*), Speeton. Sedgwick Museum. Left and right valves. × $\frac{3}{4}$.

and is sometimes, as in the example figured by Phillips (1822), perpendicular to the plane of the valves (fig. 211). In that type, which is an extreme example, the umbo is only slightly curved, but this form passes gradually into others with a strongly curved umbo. Indications of radial folds are seen in some specimens, but they are less distinct than in some foreign examples.

Some specimens show that the stage in which the posterior margin is sinuous is preceded by one in which it is only slightly concave (fig. 199). The type of *Gryphæa aquila*, Brongniart, is a small example of the *sinuata* form with the carina continued to the margin. The specimen figured by Pictet and Roux is similar, but larger, and with the carina becoming indistinct towards the margin; the large

[1] 'Nova Acta Acad. Cæs. Leop.-Carol. Nat. Cur.,' vol. xxii (1850), 2, p. 460, pl. l, fig. 2. Sharpe, 'Trans. Geol. Soc.,' ser. 2, vol. vii (1856), p. 197, pl. xxiii, fig. 3. Kitchin, 'Ann. S. African Mus.,' vol. vii (1908), p. 77.

rounded forms (like Sowerby's *sinuata*) are older individuals of the same type, and sometimes attain a height of 8 or 9 inches.

A small, oval, very inequilateral form, with a rounded carina, was named *Exogyra lærigata* by Sowerby (1829), and was stated to have come from the Irish Greensand. An examination of the type shows clearly that it was not obtained from that deposit, but from the Hythe Beds; the form of the shell and the character of the matrix agree perfectly with other examples which have been found in the Hythe Beds (figs. 208, 209).

The examples from the Lower Greensand of Upware, which were referred by W. Keeping to *Exogyra Couloni*, probably belong to this species, but the specimens seem to me too few and not sufficiently perfect to enable the identification to be made with certainty.

In England Sowerby's name (*sinuata*) has been generally used for this species, but Defrance's name (*Couloni*) has been adopted by foreign writers; the former is used here since, although Defrance's name has priority, the description was scarcely sufficient for identification and was not accompanied by either a figure or a reference to a figure.

Types.—*Gryphæa Couloni*, Defrance, from the neighbourhood of Neuchâtel. *G. sinuata*, Sowerby, from the Hythe Beds of Ashford, and *E. lævigata* from the Hythe Beds, in the British Museum. *G. aquila*, Brongniart, from the Upper Aptian of the Perte du Rhône. *G. sinuata*, Phillips, from the Speeton Clay, in the York Museum. *Exogyra subsinuata*, Leymerie, from the Neocomian of the Aube.

Distribution.—Atherfield Beds of Atherfield, Compton Bay and Sevenoaks. Ferruginous Sands of Atherfield and Shanklin. Hythe Beds of Hythe, Lympne and Maidstone. Folkestone Beds of Folkestone. *Mammillatus* bed of Okeford Fitzpaine (Dorset). Speeton Clay (zones of *Belemnites lateralis*, *B. jaculum* and *B. brunsvicensis*) of Speeton. Claxby Ironstone (zone of *B. lateralis*) of Donnington. Tealby Limestone (zone of *B. brunsvicensis*) of Claxby.

EXOGYRA TUBERCULIFERA, *Koch and Dunker*, 1837. Plate LXI, figs. 7—11.

1835. EXOGYRA SPIRALIS, *F. A. Römer.* Verstein. nord-deutsch. Oolith.-geb. p. 65 (*partim*), (non *E. spiralis*, Goldfuss).

1837. — TUBERCULIFERA, *F. C. L. Koch and W. Dunker.* Nord-deutsch Oolith.-geb., p. 54, pl. vi, fig. 8.

? 1839. — SUBPLICATA, *F. A. Römer.* Verstein. nord-deutsch. Oolith.-geb., Nachtrag., p. 25, pl. xviii, fig. 17.

1841. — — *Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 47.

— — TUBERCULIFERA, *Römer.* Ibid., p. 48.

1842. — SUBPLICATA, *A. Leymerie.* Mém. Soc. géol. de France, ser. 2, vol. v, p. 18, pl. xi. figs. 4—6.

1845. Gryphæa harpa vars. subplicata et semiplicata, *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 250, pl. iii, fig. 12.
1847. Ostrea Boussingaulti, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 702, pl. cccclxviii, figs. 6—9 (non figs. 1—3 = *O. Minos*, Coquand).
1853. — harpa, *F. J. Pictet and W. Roux.* Moll. Foss. Grès verts de Genève, p. 526, pl. xlix, fig. 2.
1854. Exogyra harpa, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 166.
1855. Ostrea Boussingaultii, *G. Cotteau.* Moll. Foss. de l'Yonne, p. 121.
1858. — Boussingaulti, *F. J. Pictet and E. Renevier.* Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 140, pl. xix, fig. 5.
1868. — — *P. de Loriol.* Valangien d'Arzier (Matér. Pal. Suisse, ser. 4), p. 50, pl. iii, figs. 14—16.
1869. — — *P. de Loriol and V. Gilliéron.* Urgon. infér. Landeron, p. 26, pl. i, fig. 23, pl. ii, figs. 1—4.
— — — *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 161 (*partim*), pl. lxiv, figs. 8—13.
— — tuberculifera, *Coquand.* Ibid., p. 189, pl. lxiii, figs. 8, 9; pl. lxvi, figs. 12, 13; pl. lxx, figs. 9—13.
1871. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 280, pl. clxxxvi, figs. 1—11.
? — — Boussingaultii, *W. A. Ooster.* Protozoe Helvetica, vol. ii, pp. 106, 127, 141, pl. xvi, figs. 5—7.
? 1884. — (Exogyra) spiralis, *O. Weerth.* Die Fauna des Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 56, pl. ix, figs. 13, 14 (? 12).
? 1892. Exogyra tuberculifera, *O. Behrendsen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xliv, p. 25.
? — — subplicata, *Behrendsen.* Ibid., p. 26.
1895. — — *G. Maas.* Ibid., vol. xlvii, p. 270.
— — spiralis, *Maas.* Ibid., p. 270.
1896. — tuberculifera, *A. Wollemann.* Ibid., vol. xlviii, p. 832.
1897. — Boussingaulti, *K. Gerhardt.* Neues Jahrb. für Min., etc., Beil.-Bd. xi, p. 175, pl. i, fig. 6.
1900. — tuberculifera, *Wollemann.* Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preuss. geol. Landesanst., N.F., pt. 31), p. 13.
1906. — — *Wollemann.* Jahrb. d. k. preuss. geol. Landesanst. u. Bergakad., vol. xxvii, p. 264.

Non 1842. Exogyra Boussingaultii, *A. d'Orbigny*. Voy. dans l'Amérique Mérid., vol. iii, pt. 4, pl. xviii, fig. 20; pl. xxi, figs. 8, 9 (= *O. Minos*, Coquand).

Description.—Left valve very convex, elongated between the umbo and the postero-ventral extremity, more or less considerably arched, with a sharp carina curving from the umbo to the extremity and becoming less prominent on the later part of the valve. Behind the carina the valve is concave or flattened, in front of it regularly convex. Umbo more or less considerably spiral. From the carina a number of rounded radial ribs extend to the margin, but are indistinct or absent on the posterior part of the valve; these give a corrugated margin to the valve; the ribs are crossed by well-marked growth-ridges. Inside the valve, at a short distance from the margin, is a band of transverse crenulations. Adductor impression large, oval, submedian, or rather near the posterior margin. The attached surface may be small or large; when large, the marginal part (except the posterior) grows vertically upwards from the support and bears ribs. Right valve nearly flat, with growth-lines; umbo small, spiral.

Affinities.—This species is related to *E. Minos*, Coquand,[1] but in the latter radial ribs occur on the right valve. It seems probable that *E. tuberculifera* has been derived from a small form of *E. sinuata*. A small example (Plate LXI, fig. 13) which agrees with the *lævigata* type of *E. sinuata*, except for the presence of radial ribs, seems to connect that species with *E. tuberculifera*.[2]

Types.—The type of Koch and Dunker is a right valve from the Neocomian of the Elligser Brink; the surface of this specimen has a tuberculate appearance because it is encrusted by another organism.[3] Later authors have been able to identify it with the forms named *E. subplicata*, Römer, and *E. Boussingaulti*, d'Orbigny, of which good figures have been published. The specimens figured by Forbes, which have a large surface of attachment, are from Atherfield, and are now in the Museum of Practical Geology (No. 25984).

Distribution.—Lower Greensand:—*Perna*-bed of Atherfield, Redcliff (Sandown), and East Shalford; Crackers of Atherfield; Ferruginous Sands of Shanklin; Hythe Beds of Lympne.

[1] D'Orbigny, 'Pal. Franç. Terr. Crét.,' vol. iii (1847), pl. cccclxviii, figs. 1—3; Coquand, 'Mon. Ostrea, Terr. Crét.' (1869), p. 183, pl. lxiv, figs. 1—3, pl. lxxiii, figs. 4—8, pl. lxxiv, figs. 14, 15; Pictet and Campiche, 'Foss. Terr. Crét. Ste. Croix' ('Mater. Pal. Suisse,' ser. 5, 1871), p. 278, pl. clxxxv; Wollemann, 'Bivalv. u. Gastrop. deutsch. u. holländ. Neocoms' (1900), p. 15; Müller, 'Deutsch.-Ost-Afrika,' vol. vii (1900), p. 548, pl. xxiii, fig. 1, text-figs. 46, 47.

[2] See also Leymerie (1842), pl. xi, fig. 4.

[3] The name *tuberculifera* is consequently inappropriate, but has been retained by several authors.

EXOGYRA CONICA (*Sowerby*), 1813. Text-figures 215—242.

1813. CHAMA CONICA, *J. Sowerby*. Min. Conch., vol. i. p. 69, pl. xxvi, fig. 3.
— — RECURVATA, *Sowerby*. Ibid., p. 69, pl. xxvi, fig. 2.
— — PLICATA, *Sowerby*. Ibid., p. 70, pl. xxvi, fig. 4.
— — HALIOTOIDEA, *Sowerby*. Ibid., p. 67, pl. xxv, figs. 1—5.
1829. EXOGYRA CONICA, *J. de C. Sowerby*. Ibid., vol. vi, p. 219, pl. dcv, figs. figs. 1—3.
? 1833. — CONICA, *A. Goldfuss*. Petref. Germ., vol. ii, p. 36, pl. lxxxvii, fig. 1.
— — SUBCARINATA, *Goldfuss*. Ibid., p. 37, pl. lxxxvii, fig. 4.
— — UNDATA, *Goldfuss*. Ibid., p. 35, lxxxvi, fig. 10.
— — HALIOTOIDEA, *Goldfuss*. Ibid., p. 38, pl. lxxxviii, fig. 1.
1837. AMPHIDONTE CONICA, *G. G. Pusch*. Polens Paläont., p. 39.
— — HALIOTOIDEA, *Pusch*. Ibid., p. 38.
1839. EXOGYRA CORNU ARIETIS, E. HALIOTOIDEA et E. AQUILA, *H. B. Geinitz*. Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 20.
1840. — PLICATULA, *Geinitz*. Ibid., pt. 2, p. 84.
? 1846. — — *A. E. Reuss*. Die Verstein. der böhm. Kreideformat., pt. 2, p. 44, pl. xxxi, figs. 5—7.
1847. OSTREA CONICA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 726, pl. cccclxxviii, figs. 5—8; pl. cccclxxix, figs. 1—3.
— — RAULINIANA, *d'Orbigny*. Ibid., p. 708, pl. cccclxxi, figs. 1—3.
— — HALIOTIDEA, *d'Orbigny*. Ibid., p. 724, pl. cccclxxviii, figs. 1—4.
1849. GRYPHÆA CONICA, *T. Brown*. Illustr. Foss. Conch. Gt. Brit. and Ireland, p. 149, pl. lx, fig. 3.
— — HALIOTOIDEA, *Brown*. Ibid., p. 149, pl. lx, figs. 6—9.
1850. OSTREA CONICA, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 171.
— — RAULINIANA, *d'Orbigny*. Ibid., p. 139.
— — HALIOTIDEA, *d'Orbigny*. Ibid., p. 171.
— EXOGYRA RAULINIANA, *J. de C. Sowerby*, in *F. Dixon*. Geol. Sussex, p. 357, (*E. haliotoidea*, p. 386, ed. 2), pl. xxvii, fig. 7.
— — CONICA, *H. B. Geinitz*. Das Quadersandst. oder Kreidegeb. Deutschland, p. 202.
1853. OSTREA RAULINIANA, *F. J. Pictet and W. Roux*. Moll. Foss. Grès verts de Genève, p. 521, pl. l, fig. 1.
1854. EXOGYRA CONICA, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 166.
— — HALIOTOIDEA, *Morris*. Ibid., p. 166.
1859. — — *T. Wiltshire*. Red Chalk of England, (Geol. Assoc.), p. 16, pl. ii, fig. 6.
— OSTREA VESICULARIS, *Wiltshire*. Ibid., p. 16, pl. ii, fig. 5.
1863. — CONICA, *A. v. Strombeck*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 109.

? 1868. Ostrea conica, *A. Briart and F. L. Cornet.* Meule de Bracquegnies (Mém. cour. et Mém. des. Sav. étrangers, vol. xxxiv), p. 45, pl. iv, figs. 3, 4.

— — haliotoidea, *Briart and Cornet.* Ibid., p. 45, pl. iv, figs. 5, 6, 8.

? 1868. Exogyra conica, *E. Eichwald.* Lethæa Rossica, vol. ii, p. 400.

1869. Ostrea conica, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 150, pl. liii, figs. 1—7.

— — haliotidea, *Coquand.* Ibid., p. 144, pl. 1, figs. 8—10; pl. lii, figs. 14—17.

— — Rauliniana, *Coquand.* Ibid., p. 157, pl. lxi, figs. 1—3.

? 1871. Exogyra haliotoidea, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 458, pl. xxxvi, fig. 7; pl. xxxvii, figs. 1—3.

1871. Ostrea Rauliniana, *F. J. Pictet and G. Campiche.* Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 307, pl. cxciii, figs. 15, 16.

— — conica, *Pictet and Campiche.* Ibid., p. 302, pl. cxciii, figs. 1, 2.

1872. — (Exogyra) conica, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 183, pl. xl, figs. 8—13; pt. 2, pl. viii, fig. 14.

— — — haliotoidea, *Geinitz.* Ibid., p. 184, pl. xli, figs. 1—13.

1875. Exogyra haliotoidea, *A. J. Jukes-Browne.* Quart. Journ. Geol. Soc., vol. xxxi, p. 296.

? 1877. — conica, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat. ii. Weissenberg. u. Malnitz. Schicht., p. 139, fig. 134.

1878. Rhynchostreon conicum, *E. Bayle.* Explicat. Carte géol. France, vol. iv, Atlas, pt. 1, pl. cxxxviii, figs. 6, 7.

1881. Ostrea conica, *J. Gosselet.* Esquisse géol. du Nord, iii, pl. xvii, fig. 11.

? 1882. Exogyra conica, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 259.

— — — *G. Seguenza.* Atti R. Accad. Lincei, ser. 3, Cl. Sci. Fis. Math., vol. xii, p. 176.

— — haliotidea, *Seguenza.* Ibid., p. 175.

1883. — conica, *vars., W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 101, pl. iv, fig. 3.

? 1885. — — *F. Nötling.* Die Fauna d. baltisch. Cenoman. (Palæont. Abhandl., vol. ii), p. 14, pl. ii, figs. 1, 2.

1890-91. Ostrea conica, *A. Peron.* Brachiopodes etc., Terr. Crét. Hauts-Plateaux de la Tunisie, p. 113, pl. xxiii, figs. 8—10.

? 1893. Ostrea sp. *cf.* haliotoidea, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 239.

1895. Exogyra conica, *E. Tiessen.* Ibid., vol. xlvii, p. 466.

? — — *cf.* haliotidea, *Tiessen.* Ibid., p. 465.

1909. — conica, *R. B. Newton.* Trans. Roy. Soc. S. Africa, vol. i, p. 51, pl. ii, figs. 8—10.

Non 1827. Chama conica, *S. Nilsson*. Petrific. Suecana, p. 28, pl. viii, fig. 4.
— 1837. — — *W. Hisinger*. Lethæa Suecica, p. 63, pl. xix, fig. 4.
? — 1841. Exogyra conica, *F. A. Römer*. Die Verstein. d. nord-deutsch. Kreidegeb., p. 47.
? — 1883. — — *A. Fritsch*. Stud. im Gebiete d. böhm. Kreidef. iii Iserschicht., p. 117, fig. 92.

Description.—Left valve very convex, with a more or less subtriangular or semi-oval outline, very inequilateral. Anterior and ventral margins rounded; posterior margin oblique, either straight, slightly concave, convex or sinuous, often forming a rounded angle with the ventral margin. Umbo spiral, curved inwards, and considerably backwards; the attached surface usually behind the umbo. A carina, generally distinct but sometimes rounded, extends in a curve from the umbo towards the postero-ventral extremity. The part of the valve behind the carina is more or less flattened, and may be concave near the umbo; the part in front of the carina is regularly convex. In large specimens the postero-ventral part is more extended and the length of the shell in relation to the height becomes relatively greater, the postero-ventral extremity is more rounded, and the carina becomes less distinct. The surface of the valve is usually smooth, except for growth-lines, but in some specimens (*undata* form) numerous somewhat irregular radial ridges are present, either in the neighbourhood of the umbo or over the entire valve. On the inside of the valve, at a short distance from the margin, is a band of small transverse ridges and pits which broadens and becomes more irregular near the postero-dorsal margin. Adductor impression rather near the postero-dorsal margin, with its upper boundary straight or slightly convex.

Right valve thin, operculiform, often slightly concave, with a small spiral umbo; surface nearly smooth; outline varying with that of the left valve.

In the forms described above (*conica* type), the surface of attachment is small, but it may be very large so that all the left valve with the exception of a narrow marginal part is fixed (*haliotoidea* and *Rauliniana* types); between these extremes every gradation is found. The free marginal part, which seldom extends to the posterior border, usually grows nearly vertically upwards from the body to which the shell is attached. When the attached surface is mainly or entirely behind the position of the carina, then the free marginal part in front is larger, and usually the shell is relatively higher and the spire of the umbo less developed, and in such cases the marginal part sometimes forms an acute angle with the attached surface.[1] The character of the surface (flat, concave, convex or irregular) to which the left valve is attached also influences the form of the shell.

Affinities.—The forms of small or moderate size, which are abundant in the

[1] See d'Orbigny, pl. cccclxxviii, figs. 1—4.

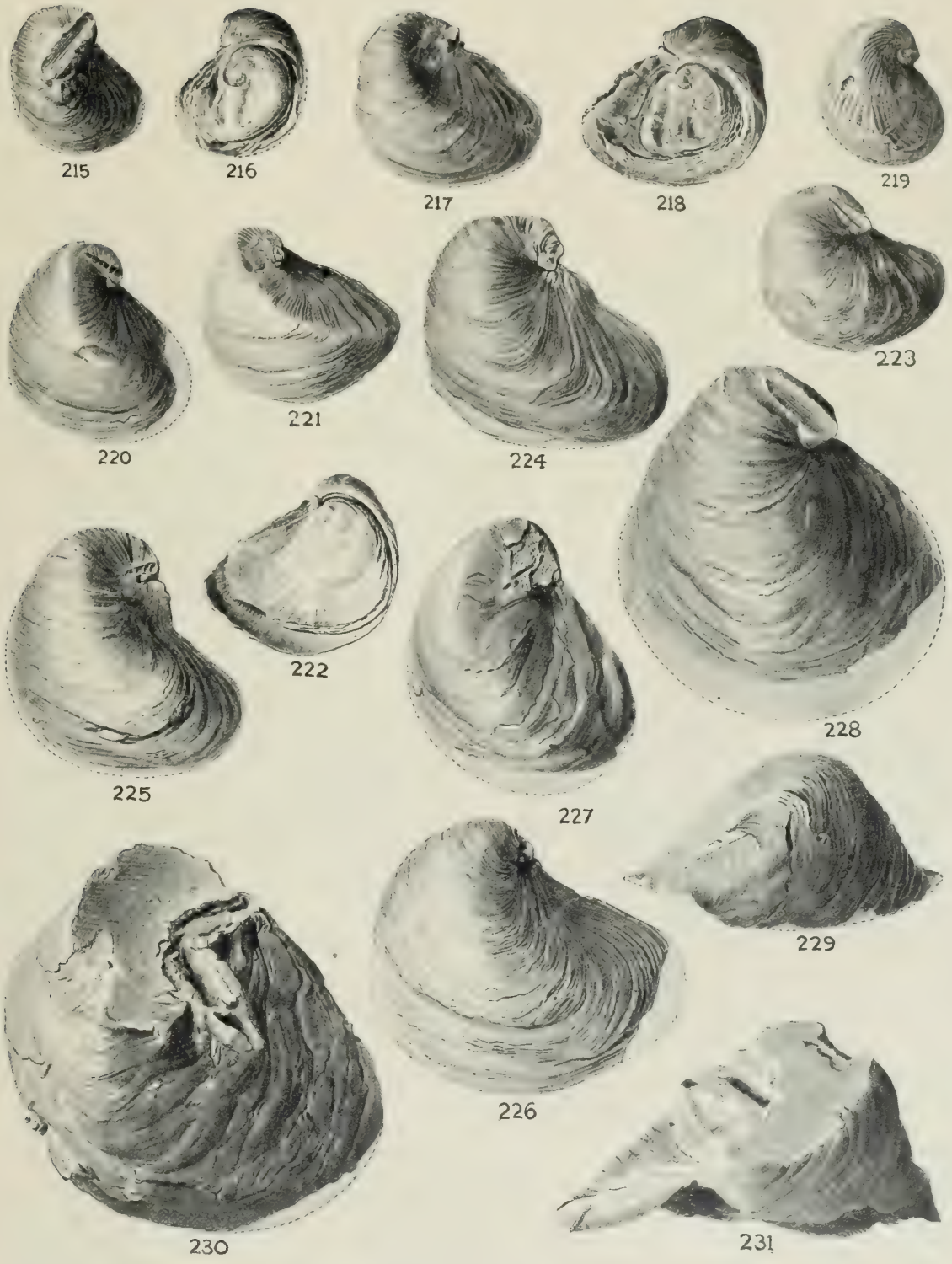
Upper Greensand, and of which typical examples were figured by Sowerby in 1829, have a small surface of attachment, and have been known in this country as *Exogyra conica* (figs. 220—225). A similar form, but of larger size, is common in the Chalk Marl (figs. 228, 229), and the Glauconitic Sandstone of Antrim; no line can be drawn between this and the smaller form of *E. conica*, with which it has been united by most authors (*e. g.* d'Orbigny, Morris, Coquand, Bayle, Peron); examples indistinguishable from *E. conica* of the Upper Greensand are associated with the larger form in Antrim, and on the other hand, some specimens found in the Upper Greensand of the south of England are of larger size than the majority of examples and cannot be separated from the larger form of *E. conica;* but nevertheless the larger form appears generally to mark a somewhat higher horizon than the smaller (*conica*, Sowerby) form.

E. haliotoidea, Sowerby, from the Upper Greensand (fig. 240), is a small form of *E. conica* with a large surface of attachment, and is connected by intermediate forms with examples having only a small attached surface. Similarly *E. Rauliniana*, d'Orbigny (fig. 236—239), from the Gault, Upper Greensand, and Lower Chalk, is a large form of *E. conica* with a large surface of attachment and is linked by a series of gradations (figs. 230—235) to the type with only a small attached surface. Peron[1] has already shown that the large specimens from the Cenomanian of France figured as *E. haliotoidea* by d'Orbigny and Coquand are only forms of *E. conica* modified by having a large surface of attachment; they occur in the same beds as undoubted examples of *E. conica*. In some specimens with a large attached surface the height of the shell is greater than usual, but this, as pointed out above, is due to the shell being fixed mainly or entirely by the posterior slope behind the carina; in such cases the free marginal part forms a sharp angle with the attached surface. Morris and Jukes-Browne united *E. haliotoidea* and *E. Rauliniana*, and Pictet and Campiche recognised the very close relationship of these two forms.

Examples from horizons above the Cenomanian have been referred to *E. haliotoidea* by some authors,[1] notably Hennig, who has compared the Senonian forms of Sweden with specimens from the Cenomanian and Gault. Without the opportunity of examining the Senonian forms I am unable to express any opinion as to

[1] 'Compte Rend. Assoc. franç. Avanc. Sci.,' xxxvi (1908), pt. 2, p. 312.

[2] *Chama haliotoidea*, Nilsson, Petrific. Suecana (1827), p. 28, pl. viii, fig. 3; Hisinger, 'Lethæa Suecica' (1837), p. 62, pl. xix, fig. 3. *Exogyra haliotoidea*, Reuss, 'Die Verstein. d. böhm. Kreideformat.,' pt. 2 (1846), p. 44, pl. xxvii, figs. 5, 9, 10, pl. xxxi, figs. 9—10; Müller, 'Petrefact. Aachen. Kreidef., pt. 1 (1847), p. 42; Schröder, 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. xxxiv (1882), p. 260, pl. xv, 5; Griepenkerl, 'Palæont. Abhandl.,' vol. iv (1889), p. 36; Hennig, 'Revis. Lamellibr. i Nilsson's 'Petrific. Suecana' (1897), p. 19, pl. i, fig. 20, pl. ii, figs. 3, 4; Rutot, 'Bull. Soc. Belge Géol. Pal. et Hydrol.,' vol. x (1897), p. 27, fig. 11.



FIGS. 215—231.—*Exogyra conica* (Sow.). 215—226, Upper Greensand. 227—231, Chalk Marl. Sedgwick Museum except 219, 224, 228. 215, 216, Niton; left and right valves. 217, 218, Ventnor; left and right valves. 219, Haldon; British Museum, No. L. 16860; left valve of ribbed variety. 220—223, zone of *Schlœnbachia rostrata*, Blackdown; left valves. 222, right valve of 221. 224, zone of *Pecten asper*, Warminster; Bristol Museum; left valve. 225, zone of *P. asper*, Evershot; left valve. 226, zone of *Schlœnbachia rostrata*, Dunscombe; left valve. 227, Folkestone; left valve. 228, 229, Blue Bell Hill, Burham; British Museum, No. L. 10382; left valve and dorsal view. 230, 231, Folkestone; left valve and dorsal view. All natural size.

their relationship. Hennig also includes *E. auricularis* (Wahlenberg)[1] in *E. haliotoidea*.

Pictet and Campiche figure and describe examples of *E. conica* from the Aptian. Specimens of *Exogyra* from the Lower Greensand of Upware, Brickhill, Faringdon and Shanklin have been referred to *E. conica*; in these the carina is more rounded

Figs. 232—242.—*Exogyra conica* (Sow.). Sedgwick Museum except 238--240. 232—235, Cambridge Greensand (base of Chalk Marl). 233, 234, left valves. 232, right valve of 233. 235, right valve of 234. 236, 237, zone of *Holaster subglobosus*, Burwell; 236, right valve; 237, anterior view of 236 showing the large size of the attached surface of the left valve. 238, 239, Gault, Folkestone; Museum of Practical Geology, No. 20873; 238, right valve; 239, anterior view showing left valve attached to a flat *Inoceramus*. 240, Upper Greensand, Devizes. Museum of Practical Geology, No. 20999. Left valve. 241, 242, Cambridge Greensand; ribbed form with a large surface of attachment; 241, left valve; 242, anterior view of 241. All natural size.

than in the common form of the species, but they agree closely with, and seem to be inseparable from some forms of *E. conica* from the Upper Greensand (figs. 215—218).

Small specimens with radial ribs (fig. 219), such as the one figured by Goldfuss

[1] 'Petrific. tell. Suec.' (1821), p. 58. See also Schröder, 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. xxxiv (1882), p. 260, pl. xv, fig. 4.

as *E. undata* and by d'Orbigny as *E. conica*, have not usually been regarded as distinct from *E. conica*.

Pictet and Campiche record *E. arduennensis* (d'Orbigny)[1] from the Upper Greensand of Blackdown, but they doubt whether that form is really distinct from *E. conica*; the chief difference is that in the former the left umbo is less prominent and less curved.

E. subconica, Vogel von Falckenstein,[2] from the Senonian is allied to *E. conica*.

Types.—The types from the Upper Greensand are in the British Museum. *Chama conica* from Chute (Warminster); *C. recurvata* and *C. plicata* from Haldon; *C. haliotoidea* (figs. 1, 3, 5 are missing) from St. Mary Donhead (Wiltshire). The specimens of *E. conica* figured by Sowerby in 1829 from the Upper Greensand of Blackdown, and the specimen figured in Dixon as *E. Rauliniana* from the Lower Chalk (probably zone of *Holaster subglobosus*) of Sussex, are in the same Museum. The specimens from the Lower Greensand of Upware, figured by Keeping, and those from the Red Limestone of Hunstanton figured by Wiltshire, are in the Sedgwick Museum.

Distribution.—Probably Lower Greensand of Upware and Faringdon. Lower and Upper Gault of Folkestone. Lower Gault of the Isle of Wight. Red Limestone of Hunstanton. Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown, Haldon, Dunscombe, Beer Head, Pinhay Cliffs, Niton, Ventnor, etc. Upper Greensand (zone of *Pecten asper*) of Evershot, Eggardon Hill, Warminster, the Dorset coast, and the Isle of Wight. Cambridge Greensand (indigenous and derived). Chloritic Marl of Compton Bay, Isle of Wight. Chalk Marl (zone of *Schlœnbachia varians*) of Folkestone, Blue Bell Hill (Burham), Reach and Stoke Ferry. Cenomanian of Wilmington, Devon, and the South Devon coast. Zone of *Holaster subglobosus* of Burham, Holborough, Dover, Arlesey, Burwell and Fulbourn.

Exogyra columba (*Lamarck*), 1819. Text-figs. 243—248.

1768. *G. W. Knorr and J. E. M. Walch.* Recueil Mon. Catastr. Pétrificat., vol. ii, p. 127, pl. D III, C, figs. 1—3.

1802. Gryphæa suborbiculata, *Lamarck.* Système Anim. sans Vert., p. 398.

1813. Gryphites ratisbonensis, *E. T. v. Schlotheim.* In Leonhard's Taschenbuch für Min., vol. vii, p. 105.

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 711, pl. cccclxii, figs. 1—4. Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1871), pp. 304, 308, pl. cxciii, fig. 3.

[2] 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. lxii (1911), p. 560, fig. 1.

1819. Gryphæa columba, *Lamarck.* Anim. sans Vert., vol. vi, p. 198.
1820. Gryphites spiratus, *E. T. v. Schlotheim.* Petrefactenk., p. 288 (*partim*).
1821. Gryphæa columba, *M. J. L. Defrance.* Dict. Sci. nat., vol. xix, p. 534.
1822. — — *J. de C. Sowerby.* Min. Conch., vol. iv, p. 113, pl. cccIxxxiii, figs. 1, 2.
— Gryphea columba, *A. Brongniart.* In Cuvier, Ossemens Fossiles, vol. ii, pp. 320, 608, pl. vi, fig. 8.
1832. Ostrea columba, *G. P. Deshayes.* Hist. nat. Vers et Mollusques (Encycl. méthod.), vol. ii, p. 302, Planches, vol. iv, pl. clxxxix, figs. 3, 4.
1833. Exogyra columba, *A. Goldfuss.* Petref. Germ., vol. ii, p. 34, pl. lxxxvi, fig. 9.
1837. — — *A. d'Archiac.* Mém. Soc. géol. de France, vol. ii, p. 185.
— Gryphæa columba, *F. Dujardin.* Ibid., p. 228.
— Amphidonte columba, *G. G. Pusch.* Polens Paläont., p. 37, pl. v, figs. 1, 2.
1839. Exogyra columba, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 20.
1841. — (Gryphæa) columba, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 46.
1846. — columba, *H. B. Geinitz.* Grundr. d. Verstein., p. 481, pl. xx, figs. 19, 20.
? — — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 43, pl. xxxi, figs. 1—4.
1847. Ostrea columba, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 721, pl. cccclxxvii.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 171.
— Exogyra columba, *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 202.
1851-52. Exogyra columba, *H. G. Bronn.* Lethæa Geogn., vol. ii, pt. 5, p. 270, pl. xxxi, fig. 10.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 166.
1857. — — *J. Ewald.* Zeitschr. d. deutsch. geol. Gesellsch., vol. ix, p. 12.
1859. Ostrea Reaumuri, *H. Coquand.* Bull. Soc. géol. de France., ser. 2, vol. xvi, p. 960.
? 1866. Ostrea *cfr.* columba, *K. A. Zittel.* Bivalv. d. Gosaugeb. (Denkschr. d. k. Akad. d. Wissensch., Wien, Math.-nat. Classe, vol. xxv, pt. ii), p. 47 [123], pl. xix, fig. 2.
? 1868. Ostrea columba, *A. Briart and F. L. Cornet.* Meule de Bracquegnies (Mém. cour. et Mém. des. Sav. étrangers, vol. xxxiv), p. 46, pl. iv, figs. 13—15.
— Exogyra columba, *E. Eichwald.* Lethæa Rossica., vol. ii, p. 404.
1869. Ostrea ratisbonensis, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 121, pl. xlv, figs. 8—12.

? 1870. Ostrea columba, *W. A. Ooster.* Protozoe Helvet., vol. ii, p. 57, pl. x, fig. 18.

— Exogyra columba, *F. Römer.* Geol. v. Oberschles., p. 332, pl. xxvi, fig. 1.

1871. Ostrea columba, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 319.

— Exogyra suborbiculata, *F. Stoliczka.* Palæont. Indica, Cret. Foss. S. India, vol. iii, p. 462, pl. xxxv, figs. 1—4.

1872. Ostrea (Exogyra) columba, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 181, pl. xl, figs. 4—7.

1877. Exogyra columba, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., ii. Weissenberg. u. Malnitz. Schicht., p. 139, fig. 135.

1878. Rhynchostreon Chaperi, *E. Bayle.* Explicat. Carte géol. France, vol. iv, Atlas, pt. 1, pl. cxxxviii, figs. 1—5.

1882. Exogyra ratisbonensis, *G. Seguenza.* Atti R. Accad. Lincei, ser. 3, Cl. Sci. Fis. Math., vol. xii, p. 181, pl. xix, fig. 1.

1890–91. Ostrea suborbiculata, *A. Peron.* Descript. Brach. etc., Terr. Crét. Tunisie, p. 119, pl. xxiii, figs. 11—13.

1893. Ostrea columba, *S. Meunier.* Le Naturaliste, p. 176, fig. 3.

— Exogyra columba, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 238.

? — — suborbiculata, *T. W. Stanton.* Colorado Formation (Bull. U.S. Geol. Survey, No. 106), p. 62, pl. v, fig. 6; pl. vi, figs. 1, 2; pl. viii, fig. 1.

1897. — columba, *R. Leonhard.* Palæontographica, vol. xliv, p. 27.

— — — *U. Söhle.* Geogn. Jahresh. (1896), p. 41.

? 1900. — — *G. Müller.* Deutsch-Ost-Afrika, vol. vii, p. 566, pl. xxiv, fig. 2.

1902. — — *P. Oppenheim.* Centralbl. für Min., etc., p. 500.

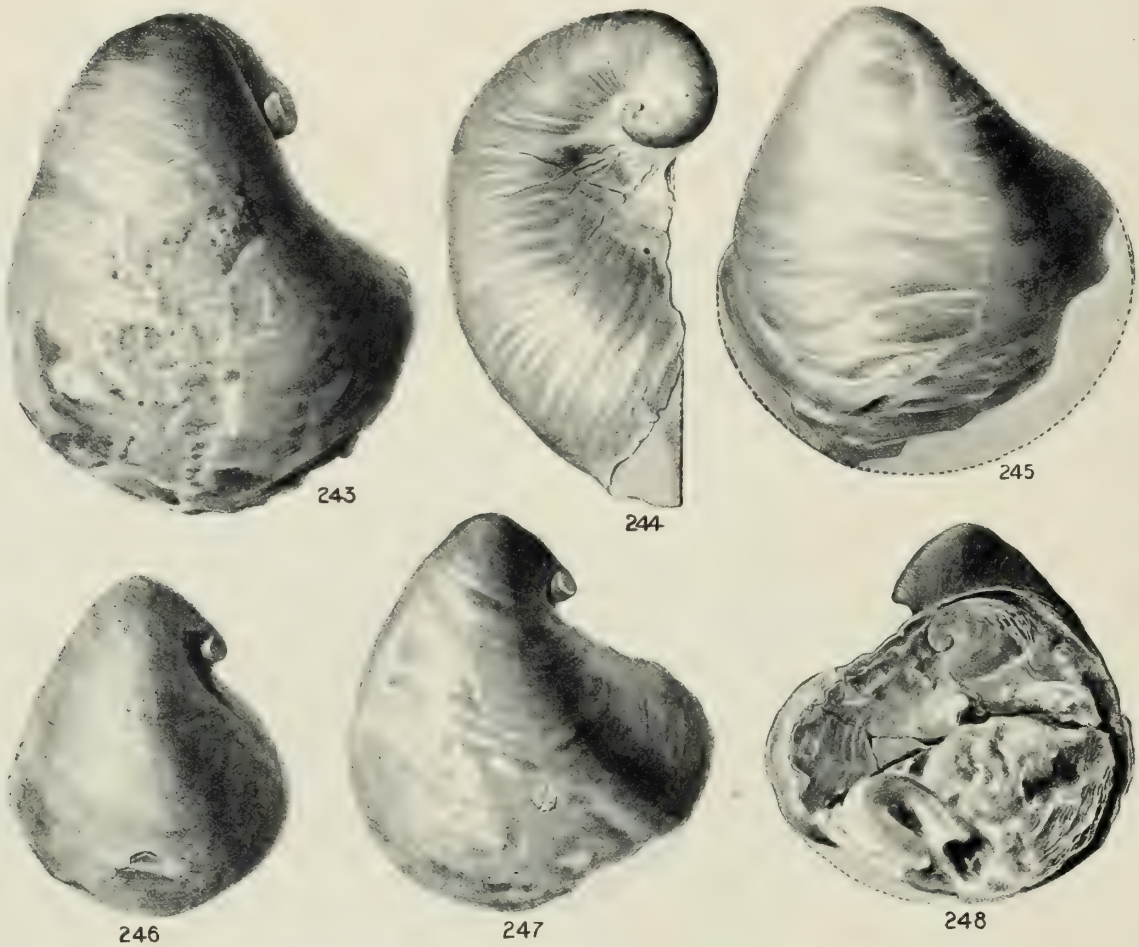
1903. Ostrea suborbiculata, *R. Fortau.* Bull. Inst. Égyptien, ser. 4, vol. iv, p. 289.

1911. Exogyra columba, *O. Schlagintweit.* Neues Jahrb. für Min., etc., Beil.-Bd. xxxiii, p. 111.

Description.—Shell very inequivalve, moderately or rather considerably inequilateral, usually higher than long and more or less ovate in outline, with, in some cases, the postero-ventral margin somewhat produced.

Left valve inflated, usually with a very small surface of attachment. Umbo usually prominent, spiral, curved more or less considerably backwards. The flank of the valve may be regularly convex, or may show a rounded carina

extending from the umbo postero-ventrally, but this often becomes indistinct in the later stages of growth ; the posterior part of the valve (behind the carina) is convex, except the postero-dorsal part near the umbo, which is concave, and here the margin is more or less concave. The surface of the valve is smooth, except



FIGS. 243—248.—*Exogyra columba* (Lam.). Zone of *Pecten asper*. 243—245, Evershot. 246—248, Eggardon Hill. 243—247, left valves. 244, posterior view of 243. 248, right valve and left umbo of 247. Sedgwick Museum, Cambridge. All × ⅔.

for growth-lines. Right valve flat, or slightly convex or concave, sometimes undulating. Umbo small, spiral.

Affinities.—This species is allied to *E. conica*, but the carina is less distinct and more rounded, the posterior part of the left valve is less flattened, and the spire of the left umbo is better developed.

Remarks.—Since the name given by Lamarck in 1819 (*columba*) has been used by the majority of later writers it seems better to retain that, rather than attempt to revive the little-known name given by the same author in 1802.

In the Cenomanian of France and other regions where this species is very abundant it is found to be much more variable than it is in the South of England. This variation is also seen in the specimens found in the Glauconitic Sandstone of Antrim. Variation is particularly noticeable in the size of the left umbo, in the extent of its curvature, the more or less inequilateral character of the shell and in the distinctness of the carina.[1]

In the Cenomanian of Algeria and Tunis, specimens, usually known as *Ostrea Mermeti*, Coquand,[2] are extremely abundant and very variable; but Peron, after comparison with numerous French specimens from the same horizon, refers these North African forms without doubt to *E. columba*.

Types.—From the Cenomanian of Le Mans. The specimens figured by Sowerby are in the British Museum; fig. 1 (upper figure) and fig. 2 are from the Cenomanian of Le Mans; fig. 1 (lower figure) is probably from the same locality although labelled "Northampton."

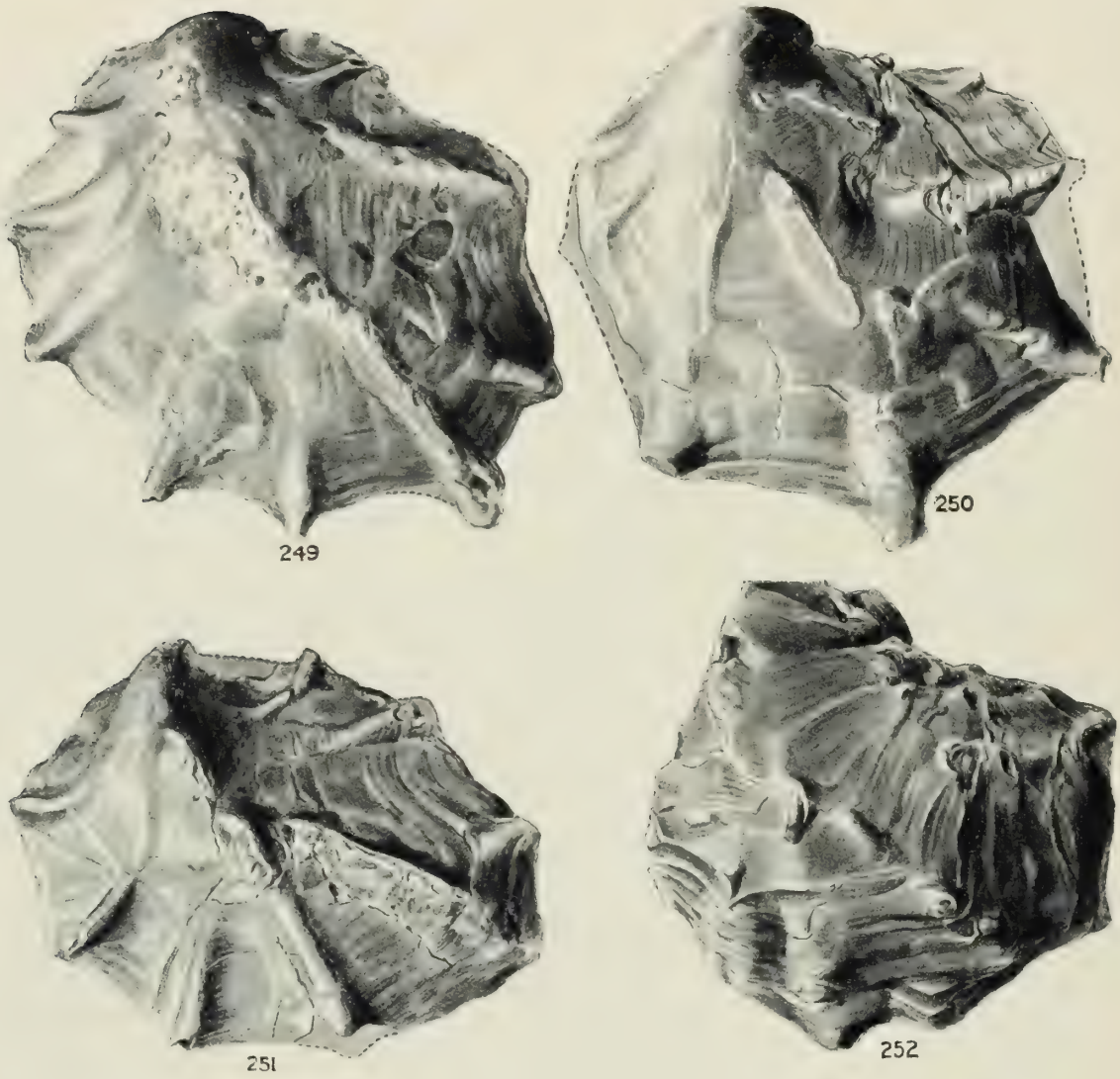
Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown, the South Devon and Dorset coasts. Upper Greensand (zone of *Pecten asper*) of the South Devon and Dorset coasts, Eversholt, Askerswell, Eggardon Hill, Littlebredy (Dorset) and Warminster. Chloritic Marl of Compton Bay, Isle of Wight. Cenomanian (Meÿer's beds 11, 12) of Beer Head.

EXOGYRA DIGITATA (*Sowerby*), 1817. Text-figs. 249—252.

1817. CHAMA DIGITATA, *J. Sowerby*. Min. Conch., vol. ii, p. 165, pl. clxxiv, figs. 1—4.
1840. EXOGYRA LACINIATA, *H. B. Geinitz*. Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 2, p. 58.
1849. GRYPHÆA DIGITATA, *T. Brown*. Illustr. Foss. Conch. Gt. Brit. and Ireland, p. 149, pl. lx, fig. 16.
1850. EXOGYRA DIGITATA. *H. B. Geinitz*. Das Quadersandst. oder Kreidegeb. in Deutschland, p. 204.
1854. — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 166.
1862. OSTREA COQUANDI, *Julien*, in H. Coquand, Géol. et Pal. Constantine, pl. xxxiii, figs. 10—12.

[1] It should be noted that the apparently small size of the left umbo in the specimens figured by some authors (*e. g.* Geinitz) is due to the fact that the specimens are internal casts from which the thick shell has been removed.

[2] *O. Mermeti*, Coquand, 'Géol. et Pal. Reg. sud Prov. Constantine' (1862), p. 234, pl. xxiii, figs. 3—5; Coquand, 'Mon. Ostrea, Terr. Crét.' (1869), p. 131, pl. lii, figs. 10—12; Lartet, 'Annal Sci. géol., vol. iii (1873), p. 60, pl. x, figs. 8—16. *O. Larteti*, Coquand, *op. cit.* (1869), p. 153, pl. lxii, figs. 15, 16. *O. Luynesi*, Lartet, *op. cit.* (1873), p. 64, pl. x, figs. 17, 18; Coquand, *op. cit.* (1869), p. 153, pl. lxii, figs. 17, 18.



FIGS. 249—252.—*Exogyra digitata* (Sow.). Upper Greensand (zone of *Pecten asper*). Left valves. 249, near Lyme Regis; British Museum, No. 52. 250, White Nothe; British Museum, No. L. 4914. 251, Evershot; Museum of Practical Geology, No. 20956. 252, Weston, South Devon; Sedgwick Museum; convex variety. All × $\frac{2}{3}$.

1868. OSTREA DIGITATA, *A. Briart and F. L. Cornet.* Meule de Bracquegnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 47, pl. iv, figs. 1, 2.

1869. — — *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 142, pl. xli, figs. 6—8.

1871. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 317.

1872. Ostrea (Exogyra) digitata, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontograph ca, vol. xx, pt. 1), p. 184, pl. xl, fig. 14.

1882. Exogyra digitata, *G. Seguenza.* Atti R. Accad. Lincei, ser. 3, Cl. Sci. Fis. Math., vol. xii, p. 180.

Description.—Shell inequilateral, with rounded outline; height and length often nearly equal.

Left valve moderately, sometimes considerably convex. Umbo spiral, curved considerably backwards; the attached surface small, and posterior to the umbo. A carina, sometimes sharp, sometimes rounded, extends in a curve from the umbo towards the postero-ventral extremity, and becomes less distinct on the later part of the valve; behind the umbo the valve is concave or flattened. A few prominent, widely separated radial folds are present; some start from the carina, others begin later, and the ventral part of the carina sometimes becomes replaced by a fold. The dorsal folds are curved. On the folds strong spine-like projections are often developed, and form projections at the margin of the valve. Fine growth-lines occur, and bend over the folds. Right valve nearly flat.

Affinities.—*O. vultur*, Coquand,[1] resembles this species in its strong folds and spines, but the left valve is more inflated and the carina less distinct. *E. digitata* shows considerable resemblance to some forms of *E. cornu arietis* (Nilsson)[2] from the Senonian, in which is included *E. laciniata* (Nilsson).

Except for the strong radial folds *E. digitata* resembles some of the less convex forms of *E. sinuata*, from which it may have been derived.

Type.—The types, from the Upper Greensand (zone of *Pecten asper*) near Sidmouth, cannot be found.

Distribution.—Upper Greensand (zone of *Pecten asper*) of Beer, Weston (Devon), Evershot, and White Nothe (Dorset).

Exogyra sigmoidea, *Reuss*, 1844. Plate LXI, fig. 12.

1844. Exogyra sigmoidea, *A. E. Reuss.* Geognost. Skizz. Böhmen, vol. ii, p. 180.

1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 44, pl. xxvii, figs. 1—4.

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[1] 'Mon. Ostrea, Terr. Crét.' (1869), p. 118, pl. xxxix, figs. 1—4. *Rhynchostreon vultur*, Bayle, 'Explicat. Carte géol. France,' vol. iv (1878), Atlas, pl. cxli.

[2] Nilsson, 'Petrific. Suecana' (1827), p. 28, pl. viii, fig. 1. Griepenkerl, 'Palæont. Abhandl.,' vol. iv (1889), p. 35, pls. v, vi, vii, figs. 6, 7. Hennig, 'Revis. Lamellibr. i Nilsson's Petrific. Suecana' (1897), p. 21. *Chama laciniata*, Nilsson, *op. cit.*, p. 28, pl. viii, fig. 2.

? 1866. Ostrea (Exogyra) sp. *cfr.* sigmoidea, *K. A. Zittel.* Bivalv. d. Gosaugeb. (Denkschr. d. k. Akad. Wissensch. Wien, Math.-nat. Cl., vol. xxxv, pt. 2), p. 123, pl. xix, fig. 5.
1869. — sigmoidea, *H. Coquand.* Mon. Ostrea, Terr. Crét., p. 93, pl. xxxiv, figs. 5—7 *bis*.
1872. — (Exogyra) sigmoidea, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 186, pl. xli, figs. 14—27.
? 1882. Exogyra *cfr.* sigmoidea, *R. Windmöller.* Jahrb. d. k. preuss. geol. Landesanst. für 1881, p. 30.
1888. — sigmoidea, *G. Müller.* Ibid. für 1887, p. 401.
1911. — — *A. Fritsch.* Stud. im Geb. d. böhmisch. Kreidef., Korycaner Schicht., p. 46, fig. 209.

Remarks.—The only English specimen I have seen is a right valve collected by Mr. Ll. Treacher. The strong carina, the concentric ribs on the anterior slope, the more sinuous and more oblique posterior margin and growth-lines distinguish this species from the *Rauliniana* form of *E. conica*. The inner margin of the valve is finely crenulate. The types came from the Lower Pläner-kalk of Schilling near Bilin.

Distribution.—Zone of *Micraster cor-anguinum* of Boxford, Berkshire.[1]

Family—RADIOLITIDÆ, *Gray*.

[Omitted from Vol. II, p. 210.]

Genus—Durania, *H. Douvillé*, 1908.

('Bull. Soc. géol. de France,' ser. 4, vol. viii, p. 309, and 'Mém. Soc. géol. de France, Paléont.,' vol. xviii, 1910, p. 23.)

Durania Mortoni (*Mantell*), 1833.

1833. Hippurites Mortoni, *G. Mantell.* Geol. S.E. England, p. 130.
1836. Conia, *R. Hudson.* Loudon's Mag. Nat. Hist., vol. ix, p. 104, fig. 19.
1838. Sphærulites Mortoni, *J. E. Gray.* Mag. Zool. Bot., vol. ii, p. 228.
1850. Hippurites Mortoni, *J. de C. Sowerby*, in *F. Dixon.* Geol. Sussex, p. 354 (p. 385, ed. 2), pl. xxvi, figs. 1, 2, 4.

[1] White and Treacher, 'Quart. Journ. Geol. Soc.,' vol. lxii (1906), p. 518.

1854. Radiolites Mortoni, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 160.
? — — sp., *Morris.* Ibid., p. 160.
1900. Biradiolites Mortoni, *H. Douvillé.* Bull. Soc. géol. de France, ser. 3, vol. xxviii, p. 230.
1904. — — *Douvillé.* Ibid., ser. 4, vol. iv, p. 174.
1909. Sauvagesia Mortoni, *A. Toucas.* Classific. et Évolut. des Radiolitidés (Mém. Soc. géol. de France, Paléont., vol. xvii), p. 92, fig. 59.
1911. Radiolites Mortoni, *F. Francke.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lxiii, Monatsber., p. 357.

Non 1855. — Mortoni, *S. P. Woodward.* Quart. Journ. Geol. Soc., vol. xi, p. 59, pl. v, figs. 1, 2.
— 1866. — — *K. A. Zittel.* Bivalv. d. Gosaugeb. (Denkschr. d. k. Akad. Wissensch. Wien, Math.-nat. Cl., vol. xxv, pt. ii), p. 72, pl. xxv, figs. 1—3.
— 1903. — — *V. Hilber.* Jahrb. d. k. geol. Reichsanst., vol. lii, (1902), p. 282.

Description.—Lower valve at first conical, afterwards becoming elongate and cylindro-conical, nearly straight or slightly arched. Longitudinal ribs strong, angular, sometimes in groups of two or three, crossed by growth-lines. Bands concave, with fine ribs; the interband convex, usually with strong ribs. Radiating grooves bifurcate once, twice or more in passing from the inner to the outer margin. The cellular structure varies in coarseness in different specimens, and sometimes becomes rather finer towards the outer margin. Upper valve not known.

Affinities.—One of the specimens figured by Sowerby (Dixon, fig. 3) is distinguished from the others by its concave interband with fine ribs and by the narrower siphonal bands; it probably belongs to another species.

Remarks.—Fragments which probably belong to this species are moderately common in the Lower Chalk, and in the Cambridge Greensand,[1] but good specimens are rare. Some examples are of considerable size, the largest being a specimen from the Cambridge Greensand, in which the lower valve has a depth of 21 inches.

Types.—Mantell's specimens cannot be traced. The examples figured by Sowerby (in Dixon, figs. 1—4), from the zone of *Holaster subglobosus*, near Lewes (probably Glynde), and the specimen figured by Hudson from Lewes, are in the British Museum.

Distribution.—Cambridge Greensand (base of Chalk Marl). Probably Chalk

[1] Another species of *Durania* is represented in the Cambridge Greensand by a form with broad, slightly concave bands with fine ribs, and a narrow, strongly concave interband with coarse ribs. The bands and interband resemble those of some species of *Sauvagesia* (Toucas, 1909, pl. xvii, figs. 1, 3, 6).

Marl (zone of *Schlœnbachia varians*) of Ventnor and Folkestone. Zone of *Holaster subglobosus* of Burham and Lewes. Zone of *Rhynchonella Cuvieri* of Dover. Zone of *Terebratulina lata* of Wouldham. Zone of *Holaster planus* of Morgan's Hill, Wiltshire.

DURANIA sp. *cf.* AUSTINENSIS (*Römer*), 1852.

1855. RADIOLITES MORTONI, *S. P. Woodward.* Quart. Journ. Geol. Soc., vol. xi, p. 59, pl. v, figs. 1, 2.

1904. BIRADIOLITES AUSTINENSIS, *H. Douvillé.* Mission Scient. Perse. III, Études géol. iv, Palćont., p. 257.

1909. SAUVAGESIA AUSTINENSIS, *A Toucas.* Classific. et Évolut. des Radiolitidés (Mém. Soc. géol. de France, Palćont., vol. xvii), p. 96, fig. 64.

1912. DURANIA AUSTINENSIS, *C. F. Parona.* Mem. R. Accad. Scienze di Torino, ser. 2, vol. lxii, p. 287, pl. ii, fig. 4.

Remarks.—In the specimen from the Upper Chalk figured by Woodward the siphonal bands are much broader than in *Durania Mortoni*, and the ribs on the convex interband are finer and more widely separated. The parts recognised by Toucas as siphonal bands were regarded by Woodward as the surfaces to which other individuals had been attached.

This species has been identified with Römer's *Hippurites austinensis* from Texas[1] by the authors quoted above, but, as Prof. Douvillé now points out, this identification must be regarded as uncertain since the essential characters of Römer's species are not yet known.[2] The finer structure of the outer layers of the shell cannot be taken as a distinguishing feature of Römer's species.

Type.—Woodward's specimens from Rosherville are in the British Museum.

Distribution.—Zone of *Micraster cor-anguinum* of Rosherville, near Gravesend.

[1] Römer, 'Kreidebild. v. Texas' (1852), p. 77, pl. vi, fig. 1.

[2] A few specimens show indications of the ligamental ridge and appear to belong to the genus *Sauvagesia, e. g.* British Museum No. 33957 from the zone of *Holaster subglobosus* of Sussex, and No. L. 4842 from the Turonian of Dover.

ADDITIONS AND CORRECTIONS.

Arca, sp. [Vol. I, p. 35.]

Internal casts of a species of *Arca* have been found in the zone of *Belemnitella mucronata* of Norwich. Two examples are preserved in the Norwich Museum (Nos. 2121, 2122).

Dicranodonta. [Vol. I, p. 53.]

Species of *Dicranodonta* have now been recognised by Borissjak[1] in the Jurassic deposits of Russia. In connection with this genus or subgenus the papers of Solger[2] and Schmidt[3] should be consulted.

Crenella orbicularis (*Sowerby*), 1836. Plate LXI, figs. 14—17.

[Omitted from Vol. I, p. 105.]

1836. Lucina? orbicularis, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 241, 341, pl. xvi, fig. 13.
1850. Lucina orbicularis, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 162 (*partim*).
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 208.
1866. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 291.
1871. Lucina? orbicularis, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 252.

Description.—Shell thin, small, oval, higher than long, slightly inequilateral, regularly convex, with rounded margins. Umbones pointed, with a small anterior curvature. Lunule and escutcheon not defined. Ornamentation consists of numerous, equal, regular, radial ribs which curve outwards from the median line of the valve and are separated by narrow furrows. A few growth-rings occur at intervals.

[1] "Pelecypoden Jura-ablager. Europæisch. Russland. II Arcidæ," 'Mém. Com. géol.,' n.s., xix (1905), pp. 29—32, 58—60, pl. iv, figs. 5—13.

[2] "Ueber *Pseudocucullæa*, einen neuen Taxodontentypus," 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. lv (1903), Monatsber., p. 76.

[3] Ibid., vol. lvi (1904), Monatsber., p. 120.

Measurements:

	(1)	(2)	(3)	(4)	
Length	7	7	6·1	6	mm.
Height	8	7·6	7	6·75	,,

(1—4) Blackdown.

Affinities.—This species has been placed in the genus *Lucina* by previous writers, but Stoliczka suggests that it belongs to *Limopsis*. Although numerous specimens have been seen, none of them shows the character of the hinge and the adductor impressions satisfactorily, but I think that the species should be referred to the genus *Crenella*. *C. inflata* (Müller)[1] from the Senonian of Aachen is a much more inflated form.

Type.—From Blackdown; in the Bristol Museum.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown, Haldon, Sidmouth.

Septifer lineatus (*Sowerby*). [Vol. I, pp. 107, 225.]

A specimen from the *Uintacrinus* band of Devizes Road, Salisbury, has been found by Dr. Blackmore. The type of *Modiola quadrata*, Sowerby (in Dixon) from Sussex is in the British Museum.

Vol. I, p. 117, footnote. The type of *Dianchora? guttata*, Sharpe (1853, pl. vi, fig. 4), is in the Museum of Practical Geology (Geological Society Collection).

Dimyodon Böhmi, *Stolley*, 1892.

Grönwall[2] states that this, or a closely allied form, occurs in the Upper Chalk of Gravesend and Grays.

Vol. I, p. 152, footnote. *For* "Müller" *read* "Nilsson." *For* Ravn "p. 9," *read* "p. 91."

Pecten (Chlamys) brittannicus, *Woods*. Plate LXI, fig. 18.

[Vol. I, p. 167, pl. xxi, figs. 1, 2.]

When this species was described only the left valve was known. A specimen from Bromley with the two valves united has since been found. The right valve

[1] Holzapfel, 'Palæontographica,' vol. xxxv (1889), p. 220, pl. xxv, figs. 17—19.

[2] 'Geol. Mag.' 1906, p. 203; Stolley, 'Die Kreide Schleswig-Holsteins' (1892), p. 243, pl. vii, fig. 8; Grönwall, 'Meddel. fra Dansk. geol. Foren.,' No. 6 (1900), p 78, pl. ii, fig. 8.

is nearly flat, and the broad radial ribs are much less distinct than on the left valve; numerous fine concentric ribs are present, and are widely spaced on the early part of the valve, but become closer together on the later part.

PECTEN (CHLAMYS) CRETOSUS, *Defrance.*

Vol. I, p. 179, line 17, delete "Clarendon and Alderbury (Salisbury)."

PECTEN (ÆQUIPECTEN) CAMPANIENSIS, *d'Orbigny.* [Vol. I, p. 192.]

A specimen of this species has been found by Dr. Rowe in the zone of *Micraster cor-testudinarium* of Dover.

LIMA (LIMEA?) sp. Plate LXI, fig. 19.

[Omitted from Vol. II, p. 52.]

A few examples of a species which resembles *Limea granulatissima*, Wollemann,[1] have been found in the Speeton Clay (zone of *Belemnites lateralis*) of Speeton. Only a young individual is figured by Wollemann, so that exact comparison cannot be made at present.

Sub-genus—PSEUDOPTERA, *Meek.*

When describing the species of *Pseudoptera* (pp. 63–69) I regarded it as a sub-genus of *Pteria*. Ligament-pits have not been seen in any English specimens, but their presence was noticed by Guéranger[2] and by Peron[3] and indicates that *Pseudoptera* cannot be associated with *Pteria*, but should probably be regarded as a sub-genus of *Gervillia*.

GERVILLIA FORBESIANA, *d'Orbigny.*

[Vol. II, p. 85, pl. xi, figs. 26, 27; pl. xii, figs. 1—5.]

This species belongs to the sub-genus *Ensigervilleia* of Dietrich.[4]

[1] 'Bivalv. u. Gastrop. d. deutsch. u. holländisch. Neocoms' (1900), p. 37, pl. ii, figs. 4, 5.

[2] 'Album Paléont. de la Sarthe' (1867), pp. 17, 20, pl. xxii, figs. 9, 10; pl. xxv, figs. 10, 11 Woods, 'Palæont. U. Cret. N. Nigeria' (1911), p. 278, footnote 1.

[3] "Descript. Brach. etc., Terr. Crét. Tunisie" (1890—91), p. 238.

[4] 'Centralbl. für Min., etc.' (1910), p. 235.

ASTARTE (ERIPHYLA) CONCINNA, *Sowerby*, 1836. Plate XVII, fig. 7 (see p. 116–118).

When describing the species of *Astarte* the only specimen of *A. concinna* known was the type, and I regarded it as probably only an individual variation of *A. striata*. Dr. Kitchin[1] has since found several specimens in the Sandgate Beds of a pit-sinking at Dover which agree with *A. concinna*, and he considers that this should be regarded as a distinct species. Dr. Kitchin also obtained *A.* (*Eriphyla*) *striata*, Sowerby, from the same place.

CRASSATELLITES, sp. [Omitted from Vol II, p. 130.]

Internal casts of a short subquadrate shell, probably belonging to the genus *Crassatellites*, occur in the Chloritic Marl of Maiden Bradley and Devizes.

CRASSATELLITES? EQUISULCATUS (*Woods*), 1897. Plate LXI, figs. 20, 21. Plate LXII, fig. 1.

[Omitted from Vol. II, p. 130.]

1897. ARCTICA? EQUISULCATA, *H. Woods*. Quart. Journ. Geol. Soc., vol liii, p. 391, pl. xxviii, figs. 6—8.

Description.—Shell convex, subquadrate, oblique, very inequilateral. Umbones anterior, pointed, with slight forward curvature. Greatest convexity between the umbones and the postero-ventral extremity; postero-dorsal part compressed. Adductor impressions distinct, the posterior one deep. Shell rather thick, ornamented with numerous concentric ribs, separated by narrow grooves.

Remarks.—The systematic position of this species is uncertain; it appears to be closely allied to the form from the Chloritic Marl mentioned above.

Type.—In the Sedgwick Museum.

Distribution.—Chalk Rock of Cuckhamsley, Berkshire.

ANTHONYA, sp. [Vol. II, p. 130.]

A portion of a left valve of *Anthonya* closely resembling *A. cantiana* has been found in the Upper Greensand (zone of *Pecten asper*) of Kingskerswell, Devon (Museum of Practical Geology, Jermyn Street, No. 997.)

[1] Lamplugh and Kitchin, 'Mesozoic Rocks in the Coal Explorations in Kent' (1911), p. 103.

CYPRINA MEYERI, *sp. nov.* Plate LXII, figs. 2, 3.

[Omitted from Vol. II, p. 141.]

Description.—Shell convex, oval, considerably inequilateral; anterior margin rounded, passing gradually into the slightly curved ventral margin; posterior margin truncated; postero-dorsal margin convex. Umbones prominent, curved inwards and forwards, with a rounded carina extending to the postero-ventral angle, and limiting a flattened postero-dorsal region. Lunular region depressed. Escutcheon long, deep, limited by a sharp carina. Ornamentation consists of concentric growth-rings. Length, 56 mm.; height, 42 mm.

Affinities.—This species shows some resemblance to *C. bernensis* (Leymerie),[1] but is less elongate and much less convex.

Type.—In the Sedgwick Museum, Cambridge (C. J. A. Meÿer collection).

Distribution.—Lower Greensand (*Perna*-bed), of Sandown.

CYPRINA? VECTIANA (*Forbes*), 1845. Plate LXII, fig. 4.

[Omitted from Vol. II, p. 141.]

1845. TELLINA? VECTIANA, *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 239, pl. ii, fig. 2.
1854. TELLINA VECTIANA, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 227.
1865. "TELLINA" VECTIANA, *F. J. Pictet and G. Campiche.* Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 141.
1871. TELLINA? VECTIANA (? HOMALINA), *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 123.

Description.—Shell triangular, moderately convex, with flattened sides, nearly equilateral. Anterior margin rounded; ventral margin slightly curved; postero-dorsal margin slightly convex, forming a rounded angle with the ventral margin. Umbones prominent, sharp, slightly curved. Lunular region depressed. Escutcheon long, limited by a rounded carina extending from the umbones to the postero-ventral extremity. Ornamentation consists of numerous strong concentric ribs, separated by narrow grooves. Length, 25 mm.; height, 17 mm.

Affinities.—This species shows some resemblance to *C. cuneata*, Sowerby, but the shell is much more compressed, and possesses distinct concentric ribs. I am not able to determine whether a postero-lateral tooth was present or not.

[1] 'Mem. Soc. géol. de France,' vol. v (1842), p. 5, pl. v, fig. 6. D'Orbigny, 'Pal. Franç. Terr. Crét.,' vol. iii, pp. 98, 759, pl. cclxxi, and 'Prodr. de Pal.,' vol. ii (1850), p. 77. Pictet and Campiche, 'Terr. Crét. Ste. Croix' ('Matér. Pal. Suisse,' ser. 4, 1865), p. 212, pl. cxiii, figs. 1, 2.

Remarks.—The type cannot be found, but other specimens named by Forbes are in the Museum of Practical Geology (Geological Society Collection, No. 2217).

Distribution.—Lower Greensand (Crackers) of Atherfield.

UNICARDIUM ? COMPRESSUM, *sp. nov.* Plate LXII, figs. 5, 6.

[Omitted from Vol. II, p. 163.]

Description.—Shell convex, with flattened or slightly concave flanks, oval or subquadrate, moderately or slightly inequilateral. Anterior margin rounded; posterior margin subtruncate, slightly oblique, curved; ventral margin nearly straight and nearly parallel to the dorsal margin. Umbones broad, close together. A rounded carina extends from the umbo to the postero-ventral extremity, limiting the compressed postero-dorsal region. External ligament broad. Ornamentation consists of a few coarse somewhat irregular concentric ribs, which are sometimes rugose, with finer ribs in the interspaces.

Measurements:

	(1)	(2)
Length	40	32 mm.
Height	26	22 ,,
Thickness	17	— ,,

(1, 2) Crackers, Atherfield.

Affinities.—The hinge and interior of this species have not been seen, consequently its generic position cannot at present be definitely determined, but it is provisionally referred to *Unicardium* on account of its external resemblance to some Jurassic species of that genus. *U.? compressum* is similar to some forms of *Mya rugosa*, Römer,[1] which has been referred to the genus *Lucina* by de Loriol and Cotteau, to *Mactromya* by Agassiz, and to *Unicardium* by Zittel.

Type.—From Atherfield, in the Sedgwick Museum, Cambridge.

Distribution.—Lower Greensand (Crackers), of Atherfield. Atherfield Clay of Dover Colliery.

UNICARDIUM ? MAILLEANUM (*d'Orbigny*), 1844. Plate LXII, figs. 7—9.

[Omitted from Vol. II, p. 165].

1844. CARDIUM MAILLEANUM, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 40, pl. cclvi, figs. 7—12.

[1] See especially de Loriol and Cotteau, 'Mon. Palćont. Gćol. Portlandien de l'Yonne' (1868), p. 135, pl. ix, figs. 10, 11.

1850. Cardium Mailleanum, *d'Orbigny*. Prodr. de Pal., vol. ii, p. 162.
1866. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 270.
1871. — — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 213 (*Lævicardium*).

Description.—Shell inflated, oval or subquadrate, longer than high, moderately inequilateral. Anterior margin rounded, passing gradually into the slightly convex ventral margin. Posterior margin high, subtruncate, forming an angle with the straight postero-dorsal margin. Postero-dorsal part of shell compressed. Umbones broad, curved forward. Ornamentation consists of concentric growth-lines and fine radial ribs.

Measurements :

	(1)	(2)	(3)	(4)	
Length	31	30	29	24	mm.
Height	27·5	27	26	21	„
Thickness	22	23	20	16	„

Base of Chalk of (1) Beaminster, (2) Maiden Newton, (3) Cerne, (4) Titherleigh.

Remarks.—This species was referred to *Cardium* by d'Orbigny, but the shell differs in form from that other Cretaceous species of that genus, and resembles more nearly *Unicardium*. The hinge is not known satisfactorily, but internal casts show indications of two cardinal teeth.

The ornamentation is often imperfectly preserved. I am indebted to M. de Grossouvre for the opportunity of examining specimens from the Cenomanian of Rouen.

Type.—From the Cenomanian of Rouen.

Distribution.—Base of the Chalk (zone of *Schlœnbachia varians*) of Beaminster, Cerne, Maiden Newton, Titherleigh and Chard.

Tellina ? phaseolina (*Phillips*), 1829. Plate LXII, fig. 10.

[Omitted from Vol. II, p. 177.]

1829. Mya phaseolina, *J. Phillips*. Geol. Yorks., p. 121 (p. 254, ed. 3), pl. ii, fig. 13.
1850. Lavignon phaseolina, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 117.
1854. Mya phaseolina, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 212.
1870. Lavignon phaseolina, *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, p. 111.

Description.—Shell small, bean-shaped, convex, considerably inequilateral; posterior part higher than the anterior part. Anterior and posterior margins rounded. Postero-dorsal margin slightly convex. Ventral margin with a slight sinuosity. A rounded carina extends from the umbo towards the postero-ventral extremity, and limits a compressed postero-dorsal area. Umbones broad, close together.

Measurements :

Length . . . 8·5 mm. Height . . . 4·5 mm.

Affinities.—This species is more elongate and more convex than *T.? subphaseolina* (see below). No specimens having the shell preserved have been found.

Type.—A specimen which is believed to be the type is in the York Museum.

Distribution.—Speeton Clay (zones of *Belemnites jaculum* and *B. brunsvicensis*) of Speeton.

TELLINA ? SUBPHASEOLINA (*d'Orbigny*), 1850. Plate LXII, figs. 11, 12.

[Omitted from Vol. II, p. 177.]

1845. LAVIGNON PHASEOLINA, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 407, pl. cccIxxvii, figs. 8—10.
1850. — SUBPHASEOLINA, *d'Orbigny.* Prodr. de Pal., vol. ii, p. 136.
1865. TELLINA PHASEOLINA, *F. J. Pictet and G. Campiche.* Terr. Crét. Ste. Croix. (Matér. Pal. Suisse, ser. 4), p. 137, pl. cviii, fig. 10.
1870. LAVIGNON SUBPHASEOLINA, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 111.
— TELLINA PHASEOLINA, *Stoliczka.* Ibid., p. 123 (? *Peronæa*).

Description.—Shell oval or subquadrate, compressed, considerably inequilateral, posterior part higher than the anterior part. Postero-dorsal margin nearly straight; posterior margin curved; ventral margin with a shallow sinus due to a depression on the sides of the shell; anterior margin rounded. Umbones small, close together; between the umbones and the postero-ventral extremity is the greatest convexity of the shell.

Measurements :

	(1)	(2)	(3)
Length	14	14	12 mm.
Height	10	9·5	8·5 „
Thickness	—	5	4· „

(1—3) Gault, Folkestone.

Affinities.—The hinge is not shown in any of the English specimens. Pictet and Campiche saw casts of the teeth, and they refer the species without doubt to

the genus *Tellina*. Externally, as was pointed out by Stoliczka, it resembles *Lepton*.

Type.—From the Gault of Gérodot (Aube).

Distribution.—Gault of Folkestone.

Cyprimeria (Cyclorisma) submersa (*Sowerby*), 1836. Plate LXII, fig. 13.

[For references see Vol. II, p. 192, foot-note.]

Description.—Shell oval, inequilateral, convex, with the postero-dorsal part flattened and limited by a rounded carina passing from the umbo to the postero-ventral angle. Antero-dorsal margin nearly straight. Anterior margin rounded, passing gradually into the moderately convex ventral margin. Posterior margin truncated. Postero-dorsal margin slightly curved. Umbones of moderate size, with a slight forward curvature. Lunule limited by a faint groove. Escutcheon elongate, bordered by a carina. Ornamentation consists of small concentric ribs.

Affinities.—The left valve, which is described above, was found by Mr. Jukes-Browne in the Exeter Museum, and appears to be referable to Sowerby's *Venus submersa*, the only apparent difference being in the greater length of the shell.

The hinge agrees closely with that of *C.* (*Cyclorisma*) *parva* (Sowerby) (p. 185). Externally the shell is similar to *C.* (*Cyclorisma*) *rotomagensis* (d'Orbigny), but is less convex, more elongated, more inequilateral, with the forward curvature of the umbones more marked and the posterior margin more distinctly truncated.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown.

Genus—Tapes, *Megerle von Mühlfeld*, 1811.

[Omitted from Vol. II, p. 194.]

Sub-genus—Icanotia, *F. Stoliczka*, 1870.

(Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 145.)

Tapes (Icanotia) sp. Plate LXII, fig. 14.

Description.—Shell elongate-oval, very inequilateral, compressed, anterior and posterior ends rounded. Ventral margin convex; postero-dorsal margin nearly straight. Umbones inconspicuous. Ornamentation consists of numerous, close, radial ribs which are indistinct on the anterior part of the valve, and become stronger and more widely separated on the posterior part, where a small rib may occur between two larger ones. Length (approximate) 55 mm., height 26 mm.

Affinities.—Only two right valves of this species have been seen. They resemble closely *Capsa elegans*, d'Orbigny,[1] but the ribs on the posterior part of the shell are more numerous and less coarse.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown and Haldon.

LEPTOSOLEN? RECTANGULARIS (*Woods*), 1897. Plate LXII, figs. 15—17.

[Omitted from Vol. II, p. 221.]

1897. TRAPEZIUM RECTANGULARE, *H. Woods*. Quart. Journ. Geol. Soc., vol. liii, p. 392, pl. xxviii, figs. 11, 12.

Description.—Shell more or less oblong, very inequilateral, moderately convex, with flattened or slightly concave sides. Anterior part not so high as the posterior part. Postero-dorsal margin nearly straight and nearly parallel to the ventral margin; anterior margin rounded; posterior margin truncated, slightly convex or nearly straight, and almost at right angles to the postero-dorsal margin. Umbones inconspicuous, with a carina extending in a curve to the postero-ventral angle, and limiting a triangular postero-dorsal area. A strong internal ridge extends from the umbo towards the opposite ventral margin. Length 19 mm., height 11 mm.

Affinities.—A similar species has been referred doubtfully by Weller[2] to *Leptosolen*. *Modiola tetragona*, Reuss,[3] also shows some resemblance to the English species. The hinge is not shown in any of the specimens, and the generic position must be regarded as uncertain.

Type.—In the Sedgwick Museum, Cambridge.

Distribution.—Chalk Rock of Cuckhamsley, Berkshire.

Vol. II, page 230, line 5 from the bottom, for "*varians*" read "*rostrata*."

THRACIA? GRACILIS (*Sowerby*), 1836. Plate LXII, figs. 18, 19.

[Omitted from Vol. II, p. 244.]

1836. PSAMMOBIA? GRACILIS, *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol. iv, pp. 242, 341, pl. xvi, fig. 12.
1850. TELLINA GRACILIS, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 159.
1854. PSAMMOBIA GRACILIS, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 222.

[1] 'Pal. Franç. Terr. Cret.,' vol. iii (1845), p. 423, pl. cccIxxxi, figs. 1, 2.
[2] 'Cret. Palæont. New Jersey' (1907), p. 626, pl. lxx, fig. 29.
[3] 'Die Verstein. der böhm. Kreideformat.,' pt. 2 (1846), p. 15, pl. xxxiii, fig. 6.

1865. Tellina gracilis, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér Pal. Suisse, ser. 4), p. 138.

? 1868. — — *A. Briart and F. L. Cornet.* Meule de Bracquegnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 80, pl. vii, fig. 19, 20.

1870. — — *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 123.

Description.—Shell elongate-oval, moderately convex, slightly inequivalve and inequilateral. Anterior margin rounded. Ventral margin slightly or moderately convex, and forming an acute angle with obliquely truncated posterior margin. Umbones incurved. A sharp carina extends in a curve from the umbo to the postero-ventral angle, and cuts off a flat or slightly concave postero-dorsal area. Ornamentation consists of concentric ribs, which are less numerous but stronger on the anterior part of the shell and the postero-dorsal area than elsewhere.

Measurements:

	(1)	(2)
Length	14	8 mm.
Height	6	4 „

(1, 2) Blackdown.

Affinities.—This species resembles *Thracia elegans* (d'Orbigny)[1] but possesses stronger concentric ribs. Its generic position cannot be determined definitely since only a few specimens have been seen, none of which shows the hinge or interior.

Type.—The type from Blackdown cannot be found.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown.

Inoceramus tuberculatus, *Woods.* [See Vol. II, p. 302.]

An example of this species has been found in the zone of *Actinocamax quadratus* of East Harnham, Salisbury, by Dr. Blackmore.

Inoceramus intermedius, *Sowerby.*

[Loudon's 'Mag. Nat. Hist.,' vol. ii (1829), p. 296, fig. 83.]

The figure given by Sowerby of a specimen from Norfolk appears to have been overlooked by previous writers; it probably represents a large form of *I. Lamarcki* var. *apicalis.*

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1845), p. 386, pl. cccIxxiii, figs. 3—5.

I.—DISTRIBUTION OF THE LOWER CRETACEOUS SPECIES IN ENGLAND.

The genera are arranged in the order of the classification followed in this work. The species of each genus or subgenus are in alphabetical order. The stratigraphical divisions are those adopted in the ' Memoirs of the Geological Survey.'

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire to Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lateralis.*	Zone of *Belemnites Jaculum.*	Zone of *Belemnites brunsvicensis.*	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
NUCULANA											
scapha (*d'Orb.*)	I, 3	...	...	×	...	...	...	...	×		
Seeleyi (*Gard.*)	I, 5	...	...	×							
spathulata (*Forb.*)	I, 1	?	...	...		...	...	...	×	×	
speetonensis, *Woods*	I, 3	×									
subrecurva (*Phill.*)	I, 2	...	×								
NUCULA											
Lamplughi, *Woods*	I, 14	...	×								
Meÿeri, *Gard.*	I, 15	...	...	...	...	...	...	...	×		
planata, *Desh.*	I, 12	...	×	×	...	...	...	...	×	×	
sp. [Cornueliana, *Gard.* non *d'Orb.*]	I, 13	...	×	...	...	...	×				
sp. [simplex, *Gard.* non *Desh.*]	I, 14	...	...	...	...	...	...	...	...	×	
ANOMIA											
convexa, *Sow.*	I, 29	...	...	...	...	...	...	...	...	×	
lævigata, *Sow.*	I, 29	...	...	...	...	...	...	...	×	×	
pseudoradiata, *d'Orb.*	I, 27	...	...	...	...	...	...	...	×	×	
ARCA											
Carteroni, *d'Orb.*	I, 33	...	...	...	...	...	×	...	×		
Dupiniana, *d'Orb.*	I, 32	...	...	...	...	...	...	...	×	×	
Sanctæ-Crucis, *Pict. & Camp.*	I, 34	...	...	...	...	...	×	...	×		
BARBATIA											
aptiensis (*Pict. & Camp.*)	I, 35	...	...	...	...	...	...	...	×	×	
marullensis (*d'Orb.*)	I, 38	...	...	...	...	...	×	?			
(Scaphula ?) Austeni (*Forb.*)	I, 37	...	...	...	...	...	...	...	×	×	
GRAMMATODON											
securis (*Leym.*)	I, 44	...		...	×		...	...	...	?	
CUCULLÆA											
Cornueliana (*d'Orb.*)	I, 50	...	...	...	...	...	?	...	×	×	
Fittoni (*Pict. & Camp.*)	I, 52	...	...	...	...	...		...	×	×	
Forbesi (*Pict. & Camp.*)	I, 49	...	...	...	...	...	...	...	×	?	
vagans, *Keep.*	I, 52	...	?	...	...	...	×				

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire to Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lateralis.*	Zone of *Belemnites Jaculum.*	Zone of *Belemnites brunsvicensis.*	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
Cucullæa											
(Dicranodonta) donningtonensis, *Keep.*	I, 54	...	×	...	...	...	×				
— obliqua (*Keep.*)	I, 55	...	...	...	...	...	×				
Pectunculus											
marullensis, *Leym.*	I, 66	...	...	...	...	...	...	...	...	×	
Trigonia											
carinata, *Ag.*	I, 90	...	...	...	...	...	...	...	×	×	
caudata, *Ag.*	I, 81	...	...	...	...	...	...	...	...	×	
Etheridgei, *Lyc*	I, 81	...	...	...	...	...	...	...	×		
exaltata, *Lyc.*	I, 74	..	...	...	...	×					
ingens, *Lyc.*	I, 75	...	×	...	...	×					
nodosa, *Sow.*	I, 78	...	...	...	...	...	...	...	×	×	×
ornata, *d'Orb.*	I, 85	...	...	...	...	...	...	...	×	×	
Robinaldina ?, *d'Orb.*	I, 74	...	...	...	×						
scapha, *Ag.*	I, 73	...	...	...	...	×					
tealbyensis, *Lyc.*	I, 79	...	×								
upwarensis, *Lyc.*	I, 86	...	...	...	...	...	×				
vectiana, *Lyc.*	I, 84	...	...	...	...	...	...	×	×	×	
Mytilus											
sp., *cf.* tornacensis, *d'Arch.*	I, 91	...	...	...	...	...	×				
Modiola											
æqualis, *Sow.*	I, 92	...	...	...	...	...	×	...	×	×	×
ligeriensis (*d'Orb.*)	I, 96	...	...	...	...	...	...	...	×		
rugosa, *Röm.*	I, 97	...	...	...	...	...	...	...	...	×	
subsimplex (*d'Orb.*)	I, 97	...	...	...	...	...	...	...	×	×	
undulata (*Forb.*)	I, 100	...	...	...	...	...	...	...	×		
(Brachydontes) vectiensis, *Woods*	I, 102	...	...	...	...	...	...	...	×	×	
Crenella											
bella (*Sow.*)	I, 104	...	...	...	...	...	...	...	×	×	
Septifer											
lineatus (*Sow.*)	I, 106	...	...	...	...	...	...	×	...	×	
Dreissensia											
lanceolata (*Sow.*)	I, 110	...	...	...	...	...	..	...	×	×	
Spondylus											
Roemeri, *Desh.*	I, 116	...	...	...	...	...	×	...	×		
striatus (*Sow.*)	I, 119	...	...	...	...	...	...	×			
Plicatula											
æquicostata, *Keep.*	I, 136	...	...	...	...	...	×				

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire to Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lateralis.*	Zone of *Belemnites Jaculum.*	Zone of *Belemnites brunsvicensis.*	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
PLICATULA											
Carteroniana, *d'Orb.*	I, 135	...	...	...	...	...	×	...	...	×	
placunea, *Lam.*	I, 134	?	...	...	...	...	...	...	?	×	
PECTEN											
(Syncyclonema) orbicularis, *Sow.*	I, 145	...	×	×	×	...	×	...	?	?	×
(Camptonectes) cinctus, *Sow.*	I, 152	...	×	×	×						
— Cottaldinus, *d'Orb.*	I, 156	...	...	...	...	...	...	...	×	×	
— striato-punctatus, *Röm.*	I, 157	...	×	×							
(Chlamys) Robinaldinus, *d'Orb.*	I, 181	...	...	...	...	...	?	×	×	×	
(Neithea) atavus, *Röm.*	I, 197	...	...	...	...	...	×	×	...	×	
— Morrisi (*Pict. & Ren.*)	I, 201	...	...	...	...	...	...	...	×	×	
— quinquecostatus, *Sow.*	I, 202	...	...	...	...	...	×	×	...	...	×
HINNITES											
Favrinus, *Pict. & Roux*	I, 220	...	...	...	...	...	...	...	×	×	
OSTREA											
canaliculata, *Sow.*	II, 375	...	...	...	...	...	×	×	...	×	
diluviana (*L.*)	II, 342	...	×	...	×	...	×	×	×	×	?
Leymerii [*Desh.*] *Leym.*	II, 355	...	...	...	...	...	...	...	?	×	
vesicularis, *Sow.*	II, 360	...	.	.	.	...	...	...	...	×	
Walkeri, *Keep.*	II, 360	...	.	.	...	...	×				
EXOGYRA											
conica (*Sow.*)	II, 407	...	...	...	...	...	×	×	...	×	
sinuata (*Sow.*)	II, 395	...	×	×	×	...	?	...	×	×	×
tuberculifera, *Koch & Dunk.*	II, 404	...	...	...	...	...	...	...	×	×	
LIMA											
(Plagiostoma) subrigida, *Röm.*	II, 10	×	⌿								
— sp. *cf.* Orbignyana, *Math.*	II, 12	...	...	...	...	...	...	...	...	×	
— sp. *cf.* villersensis ?, *Pict. & Camp.*	II, 13	...	...	...	...	...	...	×			
(Acesta) longa, *Röm.*	II, 25	×	...	...	×	...	×				
(Mantellum) farringdonensis, *Sharpe*	II, 30	...	...	...	...	...	...	×			
— parallela (*Sow.*)	II, 28	×	...	...	..	...	×	×	×	×	×
(Limatula) Dupiniana, *d'Orb.*	II, 47	...	.	...	×	...	...	...	×	×	
— Tombeckiana, *d'Orb.*	II, 45	...	...	...	×	...	×	...	...	×	
(Limea ?) sp.	II, 425	...	×								
PTERIA											
(Oxytoma) Cornueliana (*d'Orb.*)	II, 57	...	×	×	...	...	...	×			
— pectinata (*Sow.*)	II, 59	...	...	...	...	...	...	...	...	×	×
AUCELLA											
Keyserlingiana, *Trautsch.*	II, 70	...	×	×							
volgensis, *Lahus.*	II, 69	...	×								

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire and Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lateralis.*	Zone of *Belemnites Jaculum.*	Zone of *Belemnites brunsvicensis.*	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
GERVILLIA											
alæformis (*Sow.*)	II, 79	...	...	...	...	...	...	...	×	×	
Forbesiana, *d'Orb.*	II, 85	...	...	...	...	...	...	...	×	×	
linguloides, *Forb.*	II, 78	...	...	...	...	...	...	...	?	×	
sublanceolata (*d'Orb.*)	II, 74	...	...	...	...	..	...	...	×	×	?
(Pseudoptera) subdepressa (*d'Orb.*)	II, 63	...	...	...	...	...	...	...	?	×	
PERNA											
Mulleti, *Desh.*	II, 87	×	...	...	×	...	×	...	×	×	
Ricordeana, *d'Orb.*	II, 90	...	...	...	×	...	...	...	×		
INOCERAMUS											
neocomiensis, *d'Orb.*	II, 262	...	...	...	...	...	...	...	...	×	
Salomoni, *d'Orb.*	II, 263	...	...	...	...	...	...	...	...	...	×
sp.	II, 263	...	×								
PINNA											
Robinaldina, *d'Orb.*	II, 96	...	...	...	?	...	×	...	×	×	
ASTARTE											
cantabrigiensis, *Woods*	II, 107	...	...	...	...	...	×				
claxbiensis, *Woods*	II, 108	...	×								
elongata, *d'Orb.*	II, 102	...	...	...	...	...	...	×			
senecta, *Woods*	II, 106	...	×								
sinuata, *d'Orb.*	II, 104	...	...	...	...	...	...	...	...	×	
subacuta, *d'Orb.*	II, 103	...	...	...	...	...	...	...	×		
subcostata, *d'Orb.*	II, 109	...	...	...	...	...	...	...	×	?	
upwarensis, *Woods*	II, 105	...	...	...	...	...	×				
sp.	II, 107	×									
sp.	II, 111	...	...	...	...	...	...	...	...	...	×
(Eriphyla) concinna, *Sow.*	II, 426	...	...	...	...	...	...	...	...	×	
— lævis (*Phill.*)	II, 115	×	×								
— obovata, *Sow.*	II, 113	...	...	...	...	...	...	...	×	?	
— striata, *Sow.*	II, 116, 426	...	...	...	...	...	...	...	...	×	
OPIS											
neocomiensis, *d'Orb.*	II, 118	...	...	...	...	...	×	×			
CARDITA?											
fenestrata (*Forb.*)	II, 121	...	...	...	...	...	...	...	×		
CARDITA											
upwarensis, *Woods*	II, 122	...	...	...	...	...	×				
sp.	II, 123	...	...	...	...	...	...	...	×		
sp.	II, 123	...	...	...	...	...	...	...	...	×	
ANTHONYA											
cantiana, *Woods*	II, 130	...	...	...	...	...	...	...	...	...	×
sp.	II, 131	...	...	...	...	...	...	...	...	×	

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire and Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lateralis.*	Zone of *Belemnites Jaculum.*	Zone of *Belemnites brunsvicensis.*	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
CYPRINA											
anglica, *Woods*	II, 137	...	...	...	...	...	...	...	×	×	
claxbiensis, *Woods*	II, 135	...	×								
Meÿeri, *Woods*	II, 427	...	...	...	...	...	...	...	×		
obtusa, *Keep.*	II, 133	...	...	...	...	...	×				
(Venilicardia) protensa, *Woods*	II, 137	...	...	...	...	...	...	...	×	×	
Saussuri (*Bronqn.*)	II, 131	...	...	...	...	...	...	...	×	×	
Sedgwicki (*Walk.*)	II, 133	..	...	.	..	..	×				
Sowerbyi, *d'Orb.*	II, 139	...	...	...	...	...	...	...	...	×	
tealbiensis, *Woods*	II, 136	...	...	...	×						
? vectiana (*Forbes*)	II, 427	..	...	...	..	...	...	...	...	×	
sp.	II, 136	...	...	...	×						
TRAPEZIUM ?											
arcadiforme (*Keep.*)	II, 148	...	...	...	...	...	×				
squamosum (*Keep.*)	II, 148	...	...	...	...	...	×				
sp. (*cf.* striata. *Gein.*)	II, 149	...	...	...	...	...	×				
LUCINA											
sp.	II, 152	...	×								
sp.	II, 152	...	...	...	...	...	...	...	...	×	
sp.	II, 153	...	...	...	...	...	...	...	...	×	
CORBICELLA											
claxbiensis, *Woods*	II, 157	...	×								
SPHÆRA											
corrugata, *Sow.*	II, 157	...	...	...	...	...	...	...	×	×	
UNICARDIUM											
claxbiense, *Woods*	II, 162	...	×								
? compressum, *Woods*	II, 428	...	...	...	...	...	...	...	...	×	
vectense, *Woods*	II, 163	...	...	...	...	...	...	...	×	×	
THETIRONIA											
minor (*Sow.*)	II, 167	...	...	...	...	...	...	...	×	×	×
TELLINA											
Carteroni, *d'Orb.*	II, 171	...	...	...	...	...	...	...	×	×	
(Linearia) sp.	II, 175	...	...	...	...	...	...	...	×	×	
TELLINA ?											
phaseolina (*Phill.*)	II, 429	...	...	×	×						
MACTRA											
sp.	II, 177	...	...	...	...	...	...	...	...	×	
PTYCHOMYA											
Robinaldina (*d'Orb.*)	II, 179	...	...	...	...	...	...	...	×	×	

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire to Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lævalis*.	Zone of *Belemnites Jaculum*.	Zone of *Belemnites brunsvicensis*.	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
CYPRIMERIA											
(Cyclorisma) parva (*Sow.*)	II, 184	...	...	...	...	...	...	...	×	×	
— vectensis (*Forb.*)	II, 183	...	...	...	...	...	...	...	?	×	
CLEMENTIA											
(Flaventia) Ricordeana (*d'Orb.*)	II, 189	...	...	...	...	...	...	...	×	×	
PROTOCARDIA											
anglica, *Woods*	II, 194	...	...	...	...	..	...	...	...	×	
sphæroidea (*Forb.*)	II, 195	...	...	...	...	...	...	...	×	?	
sp. (*cf.* peregrinorsa, *d'Orb.*)	II, 197	...	×								
CARDIUM											
Cottaldinum, *d'Orb.*	II, 203	...	...	...	...	...	×				
Ibbetsoni, *Forb.*	II, 201	...	...	...	...	...	...		...	×	
sp.	II, 204	...	...	...	...	...	...	×			
TOUCASIA											
Lonsdalei (*Sow.*)	II, 207	...	...	...	...	...	...	×			
CORBULA											
angulata (*Phill.*)	II, 210	...	...	×	×						
striatula, *Sow.*	II, 212	...	...	...	...	...	...	...	×	×	×
PHARUS											
Warburtoni (*Forb.*)	II, 217	...	...	...	...	...	...	...	×	×	
PANOPEA											
gurgitis (*Brongn.*)	II, 222	?	...	...	...	...	?	...	×	×	?
mandibula (*Sow.*)	II, 228	...	...	...	...	...	...	...	×	×	×
spilsbiensis, *Woods*	II, 222	...	×								
sp.	II, 221	...		...	×						
sp.	II, 230	...	...	...	...	...	...	...	...	×	
MARTESIA											
constricta (*Phill.*)	II, 231	×									
prisca (*Sow.*)	II, 232	...	...	...	.	.	.	...	...	×	
TURNUS											
Dallasi (*Walk.*)	II, 233	...	...	...	...	...	×				
PLECTOMYA											
anglica, *Woods*	II, 238	...	...	...	...	...	...	...	...	×	
ANATINA											
(Cercomya) gurgitis, *Pict. & Camp.*	II, 239	...	...	...	...	...	...	...	...	×	

Genus and Species.	Volume and Page.	Yorkshire, Lincolnshire, Norfolk.					Cambridgeshire to Wiltshire.		The Weald and Isle of Wight.		
		Speeton Series. Exact horizon not known.	Zone of *Belemnites lateralis.*	Zone of *Belemnites Jaculum.*	Zone of *Belemnites brunsvicensis.*	Lower Cretaceous, West Norfolk.	Lower Greensand of Upware, Potton, Brickhill.	Lower Greensand, Faringdon, Seend, Calne.	Atherfield Beds.	Hythe and Sandgate Beds. Ferruginous Sands.	Folkestone Beds. Sandrock Beds and Carstone.
THRACIA											
Phillipsi, *Röm.*	II, 240	...	...	×					×		
Robinaldina ? (*d'Orb.*)	II, 242	...	...	...	...	...	...	...	×	×	
rotundata (*Sow.*)	II, 241	...	...	...		...	...	...	?	×	
PHOLADOMYA											
Cornueliana (*d'Orb.*)	II, 245	...	...	...	...	...	...	...	?	×	
gigantea (*Sow.*)	II, 246	...	...	...	...	...	...	...	×	×	
Martini, *Forb.*	II, 249	...	...	...	...	...	...	...	×	×	
speetonensis, *Woods*	II, 248	...	×	×	×						
MYOPHOLAS											
sp., *cf.* semicostatus (*Ag.*)	II, 253	...	...	...	...	...	...	×			
GONIOMYA											
Archiaci (*Pict. & Ren.*)	II, 254	...	...	...	...	...	...	...	...	×	
PLEUROMYA											
Orbigniana (*Rouill.*)	II, 256	...	×								

II.—DISTRIBUTION OF THE UPPER CRETACEOUS SPECIES IN ENGLAND.

Genus and Species.	Volume and Page.	Zone of *Douvilleiceras mammillatum.*	Zone of *Hoplites interruptus* and *H. lautus.*	Zone of *Schlænbachia rostrata.*	Red Chalk.	Zone of *Pecten asper.*	Zone of *Schlænbachia varians.*	Zone of *Holaster subglobosus.*	Zone of *Rhynchonella Cuvieri.*	Zone of *Terebratulina lata.*	Zone of *Holaster planus.*	Zone of *Micraster cor-testudinarium.*	Zone of *Micraster cor-anguinum.*	Zone of *Marsupites testudinarius.*	Zone of *Actinocamax quadratus.*	Zone of *Belemnitella mucronata.*	Zone of *Ostrea lunata.*
NUCULANA																	
angulata (*Sow.*)	I, 8	...	...	×													
lineata (*Sow.*)	I, 7	...	...	×	...	...	?										
Mariæ (*d'Orb.*)	I, 6	...	×	?													
phaseolina (*Mich.*)	I, 9	...	×														
solea (*d'Orb.*)	I, 5	...	×	?													
Vibrayeana (*d'Orb.*)	I, 10	...	×	×													
sp., *cf.* siliqua (*Goldf.*)	I, 11	...	...	...	...	...	...	...	...	...	×						
NUCULA																	
albensis, *d'Orb.*	I, 24	...	×	×													
antiquata, *Sow.*	I, 26	...	...	×													
gaultina, *Gard.*	I, 25	...	×														
impressa, *Sow.*	I, 23	...	...	×													
obtusa, *Sow.*	I, 22	...	...	×													
ovata, *Mant.*	I, 21	...	×	×													
pectinata, *Sow.*	I, 16	...	×	×													
— *var.* cretæ, *Gardn.*	I, 18	...	...	×													
sp.	I, 27	...	...	...	...	...	...	...	...	...	×						
(Acila) bivirgata, *Sow.*	I, 19	...	×	×													
ANOMIA																	
papyracea, *d'Orb.*	I, 31	...	...	...	...	...	...	×									
? transversa, *Seel.*	I, 30	...	...	...	...	...	×										
sp., *cf.* pseudoradiata, *d'Orb.*	I, 30	...	×														
PLACUNOPSIS																	
undulata ? (*Müll.*)	I, 224	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	×
ARCA																	
pholadiformis, *d'Orb.*	I, 35	...	...	...	...	?											
BARBATIA																	
aptiensis (*d'Orb.*)	I, 224	...	×														
Galliennei (*d'Orb.*)	I, 41, 224	...	...	...	...	...	×										
Hugardiana ? (*d'Orb.*)	I, 40	...	...	×													
marullensis (*d'Orb.*)	I, 38	...	×	×													
rotundata (*Sow.*)	I, 40	...	...	×													
vendinnensis (*d'Orb.*)	I, 41	...	...	...	...	...	×										
sp. *cf.* Geinitzi (Reuss)	I, 42	...	...	...	...	...	...	...	...	...	×						
sp.	I, 42	...	...	...	...	...	...	...	...	...	×						
sp.	I, 43	...	...	...	...	...	...	...	...	...	×						
GRAMMATODON																	
carinatus (*Sow.*)	I, 45	×	×	×	...	...	×										
TRIGONOARCA																	
Passyana (*d'Orb.*)	I, 47	...	...	...	...	×	×										
CUCULLÆA																	
glabra, *Park.*	I, 57	...	...	×													
Mailleana (*d'Orb.*)	I, 63	...	...	...	...	×	×										
nana, *Leym.*	I, 62	...	×	×													

Genus and Species.	Volume and Page.	Zone of *Douvilleiceras mammillatum.*	Zone of *Hoplites interruptus* and *H. lautus.*	Zone of *Schlænbachia rostrata.*	Red Chalk.	Zone of *Pecten asper.*	Zone of *Schlænbachia varians.*	Zone of *Holaster subglobosus.*	Zone of *Rhynchonella Cuvieri.*	Zone of *Terebratulina lata.*	Zone of *Holaster planus.*	Zone of *Micraster cortestudinarium*	Zone of *Micraster coranguinum.*	Zone of *Marsupites testudinarius.*	Zone of *Actinocamax quadratus.*	Zone of *Belemnitella mucronata.*	Zone of *Ostrea lunata.*
CUCULLÆA																	
obesa (*Pict. & Roux*)	I, 61	...	..	×	...	...	×										
venusta, *Nyst.*	I, 56	...	...	×													
sp.	I, 64	...	...	...	.	..	×										
ISOARCA																	
Agassizi, *Pict. & Roux*	I, 68	...	...	×													
obesa (*d'Orb.*)	I, 65	...	...	...	...	...	×										
PECTUNCULUS																	
euglyphus, *Woods*	I, 71	...	...	...	...	...	×										
sublævis, *Sow.*	I, 67	...	×	×													
umbonatus (*Sow.*)	I, 69	...	×	×													
Vaughani, *Woods*	I, 224	...	...	×													
LIMOPSIS																	
albensis, *Woods*	I, 71	...	×														
sp.	I, 72	...	...	...	...	...	...	...	...	...	×						
TRIGONIA																	
affinis, *Sow.*	I, 77	...	...	×	...	?	?										
aliformis, *Park.*	I, 83	...	×	×	...	×											
carinata, *Ag.*	I, 90	...	...	×	...	×											
costigera, *Lyc.*	I, 88	...	...	...	...	...	×										
crenulata, *Lam.*	I, 82	...	...	...	...	...	×										
crenulifera, *Lyc.*	I, 82	...	...	...	...	...	×										
Cunningtoni, *Lyc.*	I, 90	...	...	×													
dædalea, *Park.*	I, 80	...	...	×													
debilis, *Lyc.*	I, 78	..	...	...	...	...	×										
dunscombensis, *Lyc.*	I, 78	...	...	...	...	...	×										
eccentrica, *Park.*	I, 76	...	...	×													
Fittoni, *Desh.*	I, 88	...	×														
læviuscula, *Lyc.*	I, 77	...	...	×	...	...	?										
Meyeri, *Lyc.*	I, 84	...	...	...	...	...	×										
pennata, *Sow.*	I, 88	...	...	×	...	?	×										
scabricola, *Lyc.*	I, 82	...	...	×													
spectabilis, *Sow.*	I, 80	...	...	×													
spinosa, *Park.*	I, 86	...	...	×													
sulcataria, *Lam.*	I, 89	...	...	?	...	×	×										
Vicaryana, *Lyc.*	I, 87	...	...	×	...	?	×										
MYTILUS																	
inæquivalvis, *Sow.*	I, 91	...	...	×													
MODIOLA																	
flagellifera, *Forb.*	I, 99	...	...	×													
ligeriensis (*d'Orb.*)	I, 96	...	...	×	...	...	×										
reversa, *Sow.*	I, 94	...	...	×	...	×	×										
subsimplex (*d'Orb.*)	I, 97	...	×	×													
(Brachydontes) Guerangeri ? (*d'Orb.*)	I, 101	...	...	×	...	...	×										
— striato-costata (*d'Orb.*)	I, 103	...	...	×													
CRENELLA																	
orbicularis (*Sow.*)	II, 423	...	...	×													
LITHODOMUS																	
rugosus ? *d'Orb.*	I, 105	...	...	...	...	...	×										
SEPTIFER																	
lineatus (*Sow.*)	I, 106	...	...	×	...	×	×	×	...	...	×	...	×	×	×	×	

Genus and Species.	Volume and Page.	Zone of *Douvilleiceras mammillatum.*	Zone of *Hoplites interruptus* and *H. laudus.*	Zone of *Schlænbachia rostrata.*	Red Chalk.	Zone of *Pecten asper.*	Zone of *Schlænbachia varians.*	Zone of *Holaster subglobosus.*	Zone of *Rhynchonella Cuvieri.*	Zone of *Terebratulina lata.*	Zone of *Holaster planus.*	Zone of *Micraster cor-testudinarium.*	Zone of *Micraster cor-anguinum.*	Zone of *Marsupites testudinarius.*	Zone of *Actinocamax quadratus.*	Zone of *Belemnitella mucronata.*	Zone of *Ostrea lunata.*
DREISSENSIA																	
lanceolata (*Sow.*)	I, 110	...	...	×													
MYOCONCHA																	
cretacea, *d'Orb.*	I, 114	...	...	...	...	..	×										
SPONDYLUS																	
Dutempleanus, *d'Orb.*	I, 125	...	...	...	...	...	×	...	×	×	×	×	×	×	×	×	×
gibbosus, *d'Orb.*	I, 117	...	...	×	×												
latus (*Sow.*)	I, 121	...	...	...	...	..	...	×	×	×	×	×	×	×	×	×	
serratus, *Woods*	I, 124	...	...	...	...	..	...	...	...	...	...	...	...	×			
spinosus (*Sow.*)	I, 127	...	...	...	...	...	...	...	×	×	×	×	×	×	×	×	×
striatus (*Sow.*)	I, 119	...	...	...	...	×	×										
PLICATULA																	
Barroisi, *Peron*	I, 141	...	...	...	...	...	...	...	×	×	×	×	×	×	...	×	
gurgitis, *Pict. & Roux*	I, 137	...	×	×	×												
inflata, *Sow.*	I, 139	...	...	?	...	×	×	×									
minuta, *Seel.*	I, 138	...	...	...	×	...	?										
DIMYODON																	
Nilssoni (*Hag.*)	I,143,225	...	...	×	...	...	×	...	×	×	×	×	×	×	×	×	
PECTEN																	
(Syncyclonema) orbicularis, *Sow.*	I, 145	...	×	×	?	×	×	×									
— — *var.* haldonensis, *Woods*	I, 151	...	...	...	...	×											
(Camptonectes) curvatus, *Gein.*	I, 159	..	...	×	...	...	×										
— dubrisiensis, *Woods*	I, 162	...	...	...	...	...	×	×									
(Camptonectes ?) gaultinus, *Woods*	I, 163	...	×	?													
(Chlamys) britannicus, *Woods*	I, 167	...	...	...	...	...	...	...	...	...	...	...	×				
— cretosus, *Defr.*	I, 174	...	...	...	...	...	...	...	×	×	×	×	×	×	×	×	×
— elongatus, *Lam.*	I, 170	...	...	×	...	×	×	×									
— fissicosta, *Eth.*	I, 163	...	...	...	...	...	×	×									
— Mantellianus, *d'Orb.*	I, 179	...	...	...	...	...	...	...	...	...	...	...	×	...	...	×	
— Milleri, *Sow.*	I, 168	...	...	×	...	×											
— Puzosianus, *Math.*	I, 165	...	...	...	...	...	×										
— Robinaldinus, *d'Orb.*	I, 181	...	...	×	...	×	×										
— Stutchburianus, *Sow.*	I, 185	...	...	×													
— subacutus, *Lam.*	I, 169	...	...	...	...	?	×										
(Æquipecten) arlesiensis, *Woods*	I, 194	...	...		...	...	×	×									
— asper, *Lam.*	I, 186	...	...	...	...	×	×										
— Beaveri, *Sow.*	I, 188	...	..	×	?	...	×	×									
— campaniensis, *d'Orb.*	I, 192	...	...	...	...	...	...	...	...	...	...	×	...	×	×	×	×
— pulchellus, *Nilss.*	I, 194	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×
— pexatus, *Woods*	I, 190	...	...	...	...	...	...	...	...	×	×	...	...	×	×	×	
— sarumensis, *Woods*	I, 192	...	...	...	...	...	...	...	...	...	...	...	...	...	×	×	
— sp.	I, 191	...	...	..	...	...	...	...	...	...	×	...	...	...	×		
Nilssoni, *Goldf.*	I,152,226	...	..	...	...	...	...	...	...	...	...	...	...	...	×	...	×
(Neithea) æquicostatus, *Lam.*	I, 208	...	...	...	...	×	×										
— cometa (*d'Orb.*)	I, 200	...	...	...	...	×.	×										
— quadricostatus, *Sow.*	I, 210	...	...	×	...	×											
— quinquecostatus, *Sow.*	I, 202	...		×	...	×	×	...	...	×	×	×	×	×	×		
— sexcostatus, *Woodw.*	I, 214	...	..	...	...	...	×	×	...	...	...	...	?	?	×	×	
— striatocostatus, *Goldf.*	I, 217	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×
VELOPECTEN																	
pectinatus (*Seel.*)	I, 220	...	...	×													
Studeri (*Pict. & Roux*)	I, 218	...	...	×	×	?											
trilinearis (*Seel.*)	I, 219	...	...	×													

Genus and Species.	Volume and Page.	Zone of *Douvilleiceras mammillatum.*	Zone of *Hoplites interruptus* and *H. lautus.*	Zone of *Schlænbachia rostrata.*	Red Chalk.	Zone of *Pecten asper.*	Zone of *Schlænbachia varians.*	Zone of *Holaster subglobosus.*	Zone of *Rhynchonella Cuvieri.*	Zone of *Terebratulina lata.*	Zone of *Holaster planus.*	Zone of *Micraster cortestudinarium.*	Zone of *Micraster anguinum.*	Zone of *Marsupites testudinarius.*	Zone of *Actinocamax quadratus.*	Zone of *Belemnitella mucronata.*	Zone of *Ostrea lunata.*
OSTREA																	
Boucheroni, *Coq.*	II, 391	...	...	...	...	...	...	...	...	...	×	...	×	×	×		
canaliculata (*Sow.*)	II, 375	...	×	×	...	×	×	×	×	×	×	×	×	×	×	×	×
cunabula, *Seel.*	II, 358	...	...	...	...	...	×										
diluviana (*L.*)	II, 342	...	...	×	...	×	×	×									
incurva, *Nilss.*	II, 388	...	...	...	...	...	×	×	×	×	...	...	×	×	×	×	
Leymerii [*Desh.*] *Leym.*	II, 355	×															
lunata, *Nilss.*	II, 393	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	✓
sarumensis, *Woods*	II, 387	...	...	...	...	..	...	...	..	...	...	...	..	...	×		
semiplana, *Sow.*	II, 379	...	...	...	...	...	...	...	...	?	×	×	×	×	×	×	×
vesicularis, *Lam.*	II, 360	...	?	×	...	×	×	×	×	×	×	×	×	×	×	×	×
vesiculosa (*Sow.*)	II, 374	...	...	×	...	×	×										
EXOGYRA																	
columba (*Lam.*)	II, 413	...	...	×	...	×	×										
conica (*Sow.*)	II, 407	...	×	×	×	×	×	×									
digitata (*Sow.*)	II, 417	...	...	...	...	×											
sigmoidea, *Reuss*	II, 419	...	...	...	...	...	...	...	...	...	...	...	×				
LIMA																	
aspera (*Mant.*)	II, 8	...	...	...	...	...	×	×									
canalifera, *Goldf.*	II, 1	...	...	...	...	×											
Galliennei, *d'Orb.*	II, 3	...	...	×	...	...	×										
scabrissima, *Woods*	II, 7	...	...	...	...	×											
subovalis, *Sow.*	II, 5	...	...	×	...	×	×										
vectensis, *Woods*	II, 4	...	...	...	...	×											
(Plagiostoma) cretacea, *Woods*	II, 22	...	...	...	...	...	...	...	...	×	×	×	×	×	×	×	×
— globosa, *Sow.*	II, 16	...	×	...	×	×	×	×									
— Hoperi, *Mant.*	II, 17	...	...	...	...	...	...	...	...	×	×	×	×	×	×	×	×
— Marrotiana, *d'Orb.*	II, 24	...	...	...	...	...	...	...	..	...	...	...	...	...	...	×	...
— Meyeri, *Woods*	II, 15	...	...	...	...	×	×										
— semiornata, *d'Orb.*	II, 14	...	...	×	...	×	×										
(Acesta) clypeiformis, *d'Orb.*	II, 26	...	...	...	...	×											
(Mantellum) britannica, *Woods*	II, 38	...	...	...	...	...	...	...	...	..	...	...	×				
— cantabrigiensis, *Woods*	II, 37	...	...	...	...	...	×										
— elongata (*Sow.*)	II, 34	...	...	...	...	...	×	×									
— — *var.* echinata, *Eth.*	II, 36	...	...	...	...	...	?	×									
— gaultina, *Woods*	II, 31	...	×	×													
— interlineata, *Jukes-Browne*	II, 32	...	...	×													
— intermedia, *d'Orb.*	II, 33	...	...	...	...	×											
— Reichenbachi, *Gein.*	II, 39	...	...	...	...	×	×										
— sp.	II, 40	...	...	...	...	...	×										
(Ctenoides) divaricata, *Dujard.*	II, 44	...	...	...	...	...	...	...	...	×	×	...	×	×	×	×	
— rapa, *d'Orb.*	II, 40	...	...	...	...	×	×										
— tecta, *Goldf.*	II, 42	...	...	...	...	...	×										
(Limatula) decussata, *Goldf.*	II, 50	...	...	...	...	...	...	...	...	...	...	...	...	×	×	×	
— Fittoni, *d'Orb.*	II, 48	...	...	×	...	.	×										
— subæquilateralis, *d'Orb.*	II, 49	...	...	...	...	×											
— wintonensis, *Woods*	II, 51	...	...	...	...	...	...	...	...	...	...	...	?	...	×		
— sp.	II, 52	...	...	...	...	..	...	...	...	...	...	...	...	...	...	×	
(Limea ?) composita (*Sow.*)	II, 53	...	...	...	...	×											
— granulata (*Nilss.*)	II, 54	...	...	...	...	...	...	...	...	...	...	...	...	...	×	×	×
PTERIA																	
(Oxytoma) dubia (*Eth.*)	II, 60	...	...	...	...	...	...	×									
— pectinata (*Sow.*)	II, 59	...	...	×													
— tenuicostata (*Röm.*)	II, 61	...	...	...	...	...	...	...	...	...	...	...	...	...	×		
— sp.	II, 60	...	...	...	...	...	...	×									

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AUCELLINA																	
gryphæoides (*Sow.*)	II, 72	...	...	×	×	×	×	×									
GERVILLIA																	
Forbesiana, *d'Orb.*	II, 85	...	×	×													
rostrata (*Sow.*)	II, 83	...	...	×													
sublanceolata (*d'Orb.*)	II, 74	...	...	×													
(Pseudoptera) anomala (*Sow.*)	II, 64	...	...	×													
— cœrulescens (*Nilss.*)	II, 67	...	...	...	...	...	...	...	...	...	...	...	...	...	×	×	×
— gaultina, *Woods*	II, 67	...	×														
— haldonensis, *Woods*	II, 66	...	...	...	...	×											
PERNA																	
oblonga, *Seel.*	II, 93	...	...	×													
Rauliniana, *d'Orb.*	II, 92	...	×	×													
semielliptica, *Seel.*	II, 94	...	...	×													
sp. (lanceolata, *Seel.*)	II, 95	...	...	×													
sp. (subspathulata, *Seel.*)	II, 95	...	...	×													
INOCERAMUS																	
anglicus, *Woods*	II, 264	...	?	×	×												
balticus, *Böhm*	II, 293	...	...	...	...	...	...	...	...	...	...	...	...	?	×	×	
cardissoides, *Goldf.*	II, 300	...	...	...	...	...	...	...	...	...	...	...	...	...	×		
concentricus, *Park.*	II, 265	...	×	×	×												
— *var.* subsulcatus, *Wiltsh.*	II, 268	...	...	×	×												
cordiformis, *Sow.*	II, 334	...	..	...	...	...	...	...	...	...	...	×	×	×			
corrugatus, *Woods*	II, 340	...	...	...	...	...	...	...	...	...	...	...	×				
costellatus, *Woods*	II, 336	...	...	...	...	...	...	...	...	...	×						
Crippsi, *Mant.*	II, 273	...	...	...	...	×	×	×									
— *var.* reachensis, *Eth.*	II, 278	...	...	...	...	...	×	×									
digitatus, *Sow.* (Chalk)	II, 337																
Etheridgei, *Woods*	II, 278	...	...	...	...	×	×	×									
inconstans, *Woods*	II, 285	...	...	...	...	...	...	...	...	?	×	×	×	...	×	×	
— *var.* sarumensis, *Woods*	II, 293	...	...	...	.	...	...	...	...	...	...	...	...	...	×		
— *var.* striatus, *Mant.*	II, 292	...	...	...	...	...	...	...	...	...	×	...	×				
involutus, *Sow.*	II, 327	...	...	...	...	...	...	...	...		...	×	×				
labiatus (*Schloth.*)	II, 281	...	...	...	...	...	...	...	×	×							
— *var.* latus, *Sow.*	II, 284	...	...	...	...	...	...	...	...	?	×						
Lamarcki, *Park.*	II, 307	...	...	...	...	...	...	...	×	×	×	×	×				
— *var.* apicalis, *Woods*	II, 319	...	...	...	...	...	...	...	×	×	×						
— *var.* Cuvieri, *Sow.*	II, 320	...	...	...	...	...	...	...	...	×	×	×	×				
— *var.* Websteri, *Mant.*	II, 319	...	...	...	...	...	...	...	...	...	×	×					
lingua, *Goldf.*	II, 299	...	...	...	...	...	...	...	...	...	...	...	...	?	...	×	
lobatus, *Goldf.*	II, 296	...	...	...	...	...	...	...	...	...	...	...	...	...	×		
pictus, *Sow.*	II, 279	...	...	...	...	...	×	×									
pinniformis, *Will.*	II, 338	...	...	...	...	...	...	...	...	...	...	...	...	...	×		
Salomoni, *d'Orb.*	II, 263	×															
sulcatus, *Park.*	II, 269	...	...	×	×												
tenuis, *Mant.*	II, 271	...	...	×	×	?	×										
tuberculatus, *Woods*	II, 302	...	...	...	...	...	...	...	...	...	...	...	...	...	×		
undulato-plicatus, *Röm.* (Senonian)	II, 304																
— *var.* digitatus, *Schlüt.*	II, 307	...	...	...	...	...	...	...	...	...	...	...	×	...	×		
sp.	II, 271	.	...	×													
PINNA																	
decussata, *Goldf.*	II, 99	...	....	...	...	...	×	...	...	×	×	?	×	...	?	×	×
Robinaldina, *d'Orb.*	II, 96	...	×	×													
tegulata, *Eth.*	II, 99	...	...	...	...	...	...	×									

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ASTARTE																	
formosa, *Sow.*	II, 112	...	...	×													
impolita, *Sow.*	II, 113	...	...	×													
Omalioides, *Woods*	II, 111	...	..	×													
(Eriphyla) concinna (*Sow.*)	II, 426	...	..	×													
— obovata, *Sow.*	II, 113	...	..	×													
— striata, *Sow.*	II, 116	...	...	×													
OPIS																	
haldonensis, *Woods*	II, 119	...	...	×													
sp.	II, 120	...	...	×													
CARDITA																	
cancellata, *Woods*	II, 127	...	...	...	...	...	...	...	...	...	×						
Cottaldina, *d'Orb.*	II, 126	...	...	...	...	...	×										
tenuicosta (*Sow.*)	II, 124	...	×	×													
sp.	II, 127	...	...	...	..	...	×										
CRASSATELLITES																	
divisiensis, *Woods*	II, 128	...	...	×	...	?											
? equisulcatus (*Woods*)	II, 426	...	...	...	...	...	...	...	..	...	×						
vindinnensis (*d'Orb.*)	II, 129	...	...	...	...	...	×										
ANTHONYA																	
cantiana ? *Woods*	II, 426	...	...	...	...	×											
CYPRINA																	
cuneata, *Sow.*	II, 134	...	...	×													
ligeriensis, *d'Orb.*	II, 145	...	...	...	...	?	×										
(Venilicardia) angulata (*Sow.*)	II, 141	...	?	×													
— lineolata (*Sow.*)	II, 143	...	...	×													
— ?) quadrata (*d'Orb.*)	II, 146	...	...	×	...	×	×	...	...	...	×						
— truncata (*Sow.*)	II, 145	...	...	×													
TRAPEZIUM																	
trapezoidale (*Röm.*)	II, 149	...	...	...	...	...	...	...	...	...	×	...	...	...	...	×	
ISOCARDIA																	
similis, *Sow.*	II, 151	×															
LUCINA																	
Downesi, *Woods*	II, 155	...	...	×													
pisum, *Sow.*	II, 156	...	...	×													
? sculpta, *Phill.*	II, 153	...	×														
tenera, *Sow.*	II, 154	...	×	×													
SPHÆRA																	
sp.	II, 159	...	...	...	...	...	×										
MUTIELLA																	
? canaliculata (*Sow.*)	II, 160	...	...	×													
rotundata (*d'Orb.*)	II, 161	...	...	...	...	...	×										
UNICARDIUM																	
? gaultinum (*Pict. & Roux*)	II, 163	...	.	×													
? Mailleanum (*d'Orb.*)	II, 428	...	...	...	...	...	×										
ringmeriense (*Mant.*)	II, 164	...	...	×	...	...	×										
sp.	II, 163	...	...	×													
THETIRONIA																	
lævigata (*Sow.*)	II, 169	...	×	×													

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TELLINA																	
striatuloides, *Stol.*	II, 172	...	...	×	...	?											
subphaseolina, *d'Orb.*	II, 430	...	?	?													
(Palæomœra) inæqualis, *Sow.*	II, 173	...	...	×													
(Linearia) subtenuistriata, *d'Orb.*	II, 175	...	...	×													
— sp.	II, 177	...	...	×													
MACTRA																	
angulata, *Sow.*	II, 177	...	...	×													
DOSINIOPSIS																	
caperata (*Sow.*)	II, 182	...	...	×													
subrotunda (*Sow.*)	II, 181	...	...	×													
CYPRIMERIA																	
(Cyclorisma) faba (*Sow.*)	II, 187	...	×	×													
— rotomagensis (*d'Orb.*)	II, 186	...	...	...	...	...	×										
— sublævis (*Sow.*)	II, 189	...	...	×													
— submersa (*Sow.*)	II, 431	...	...	×													
CLEMENTIA																	
(Flaventia) ovalis, *Sow.*	II, 191	...	...	×													
CALLISTA																	
plana (*Sow.*)	II, 192	...	...	×													
TAPES																	
(Icanotia) sp.	II, 431	...	...	×													
PROTOCARDIA																	
Hillana (*Sow.*)	II, 197	...	...	×	...	...	×										
sp.	II, 196	...	...	...	...	×											
CARDIUM																	
turoniense, *Woods*	II, 204	...	...	...	...	...	...	...	...	...	×						
sp. (*cf.* cenomanense, *d'Orb.*)	II, 205	...	...	...	...	...	...	...	...	...	×						
sp.	II, 205	...	...	...	...	...	...	...	...	...	...	...	...	...	..	×	
(Granocardium) proboscideum, *Sow.*	II, 205	...	...	×													
GYROPLEURA																	
cornucopiæ (*d'Orb.*)	II, 208	...	...	...	...	..	×										
inequirostrata (*Woodw.*)	II, 209	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	
sp.	II, 210	...	...	.	...	...	...	...	...	...	...	...	...	...	×		
DURANIA																	
Mortoni (*Mant.*)	II, 420	...	...	...	...	...	×	×	×	×	×						
— sp. *cf.* austinensis (*Röm.*)	II, 422	...	...	...	...	...	...	...	...	...	...	...	×				
CORBULA																	
elegans, *Sow.*	II, 216	...	...	×													
gaultina, *Pict. & Camp.*	II, 214	...	×														
truncata, *Sow.*	II, 215	...	...	×													
SOLECURTUS ?																	
(Azor ?) Actæon, *d'Orb.*	II, 219	...	...	×	...	...	×										
— Pelagi, *d'Orb.*	II, 218	...	...	×													
LEPTOSOLEN																	
Dupinianus (*d'Orb.*)	II, 219	...	×	×													
? rectangularis (*Woods*)	II, 432	...	...	...	...	...	...	...	...	...	×						
PANOPEA																	
gurgitis (*Brongn.*)	II, 222	×	×	×													

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PANOPEA																	
mandibula (*Sow.*)	II, 228	...	×	×	...	...	×										
Meyeri, *Woods*	II, 229	...	...	×													
ovalis, *Sow.*	II, 229	...	...	×													
MARTESIA																	
constricta (*Phill.*)	II, 231	...	×	×													
? rotunda (*Sow.*)	II, 233	...	...	...	...	...	...	...	...	...	×						
TURNUS ?																	
amphisbæna (*Goldf.*)	II, 235	...	...	...	...	...	×	×	×	×	×	×	×	×	×		
sp. (*cf.* argonnensis, *Buv.*)	II, 234	...	×														
sp.	II, 235	...	...	×													
TEREDO																	
gaultina, *Woods*	II, 237	...	?	×													
ANATINA																	
(Cercomya), sp.	II, 239	...	...	×													
— sp.	II, 240	...	...	?	...	?	×										
THRACIA																	
carinifera (*Sow.*)	II, 244	...	...	...	...	...	×										
? gracilis (*Sow.*)	II, 432	...	...	×													
Sanctæ-Crucis, *Pict. & Camp.*	II, 243	...	×														
sp.	II, 244	...	×	×													
PHOLADOMYA																	
cordata, *Tate*	II, 253	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	
decussata (*Mant.*)	II, 250	...	...	×	...	...	×	×									
Fabrina, *d'Orb.*	II, 250	...	×	×													
GONIOMYA																	
Mailleana (*d'Orb.*)	II, 255	...	...	×	...	...	×										
LIOPISTHA																	
(Psilomya) gigantea (*Sow.*)	II, 257	...	...	×													
sp.	II, 258	...	...	...	×												
CUSPIDARIA																	
pulchra (*Sow.*)	II, 260	...	...	...	...	...	...	...	...	...	×	...	...	...	...	×	
Sabaudiana (*Pict. & Camp.*)	II, 259	...	×														
undulata (*Sow.*)	II, 260	...	×														

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PLATE LV.

Genus—OSTREA, *Linnæus*.

FIGS.

1—3. *O. Walkeri*, Keep. Lower Greensand, Upware. Sedgwick Museum, Cambridge. (P. 360.)

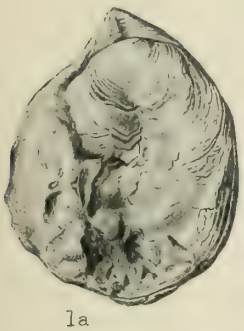
1. The Type. *a*, right valve; *b*, left valve; *c*, anterior view.
2, 3. Interiors of left valves.

4—9. *O. vesicularis*, Lam. (P. 360.)

4. Probably zone of *Holaster planus*, Swaffham, Norfolk. Norwich Museum, No. 3290. Young individual attached to *Micraster*. Right valve and portion of left valve.
5. Gault, Folkestone. Sedgwick Museum. *a*, right valve; *b*, anterior view showing left valve almost entirely attached to a flat portion of *Inoceramus*.
6. Zone of *Belemnitella mucronata*, Norwich. Dr. Rowe's Collection. Attached obliquely to a *Belemnitella*. *a*, right valve; *b*, anterior view.
7. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. *a*, right valve; *b*, anterior view showing the larger part of the left valve attached to a flat *Inoceramus*.
8, 9. Zone of *Holaster subglobosus*, Blue Bell Hill, Burham. British Museum, Nos. L 10408, L 10409. 8, 9*a*, left valves; 9*b*, dorsal view of 9*a*, showing the small surface of attachment.

10—14. *O. vesiculosa* (Sow.) Upper Greensand. Left valves. (P. 374.)

10. Zone of *Pecten asper*, Ballard Down. Sedgwick Museum. *b*, posterior view.
11. Zone of *Pecten asper*, Warminster. Museum of Practical Geology, No. 25942.
12. Zone of *Schlœnbachia rostrata*, Isle of Wight. Same museum, No. 25936. *b*, posterior view.
13. Zone of *Schlœnbachia rostrata*, Potterne. Same museum, No. 25932, *b*, posterior view.
14. Zone of *Schlœnbachia rostrata*, Dinton. Same museum, No. 25938. *b*, posterior; *c*, interior.


1a

1b.

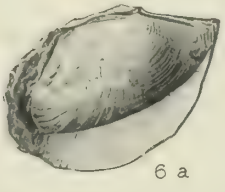
1c

2

3

5a

5b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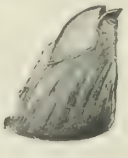
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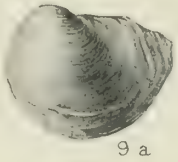
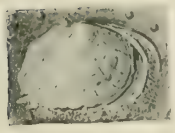

9a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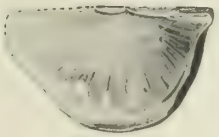
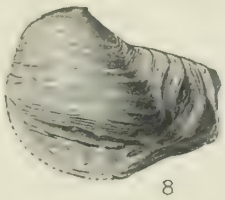

7a

7b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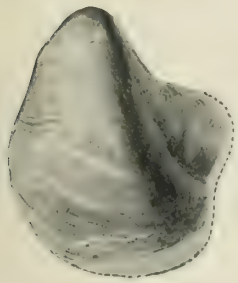
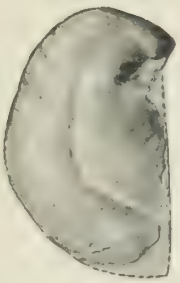
9b


10a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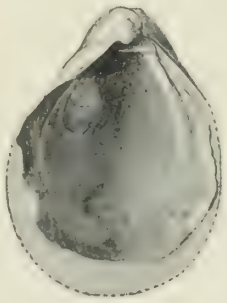
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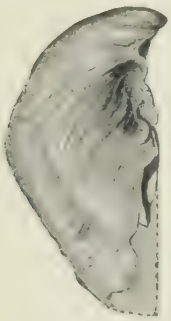
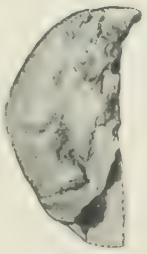
12a

12b

13a


13b

14a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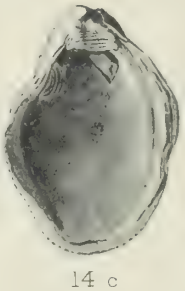
14c

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PLATE LVI.

Ostrea (*continued*).

Figs.

1. *O. vesiculosa* (Sow.). Upper Greensand (zone of *Schlœnbachia rostrata*), Dinton. Museum of Practical Geology, No. 25937. *a*, left valve; *b*, posterior view. (P. 374.)

2—16. *O. canaliculata* (Sow.). (P. 375.)

2. Gault, Folkestone. Museum of Practical Geology, No. 20819. *a*, left valve; *b*, right valve.

3—5. Gault, Folkestone. British Museum, Nos. L 4927, L 23044. 3*a*, left valve; 3*b*, dorsal view. 4, interior of left valve. 5, interior of right valve.

6. Upper Greensand (zone of *Pecten asper*), Warminster. Sedgwick Museum. *a*, left; *b*, right valve.

7. Zone of *Holaster subglobosus*, Burwell. Sedgwick Museum. Left valve.

8. Melbourn Rock, Hitchin. Sedgwick Museum. *a*, left valve; *b*, anterior view.

9. *Uintacrinus* band, Devizes Road, Salisbury. Dr. Blackmore's Collection. Left valve.

10, 11. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. 10*a*, left valve; 10*b*, portion × 5. 11*a*, right valve and part of left valve; 11*b*, posterior view.

12. Same horizon and collection. West Harnham. *a*, left valve; *b*, posterior view.

13. Zone of *Actinocamax quadratus*, Marwell, Hants. Sedgwick Museum. Left valve.

14, 15. Zone of *Belemnitella mucronata*, Norwich. Dr. Rowe's Collection. 14*a*, 15*a*, left valves; 14*b*, 15*b*, right valves and parts of left valves.

16. Zone of *Belemnitella mucronata*, Alderbury Well. Dr. Blackmore's Collection. Left valve.

17—19. *O. semiplana*, Sow. Upper Chalk. (P. 379.)

17. Zone of *Belemnitella mucronata*, Norwich. Norwich Museum, No. 2135. Left valve.

18. Same horizon, locality and museum. No. 2130. *a*, right valve; *b*, left valve.

19. *Uintacrinus* band, Thanet coast. Dr. Rowe's Collection. *a*, right valve; *b*, left valve.

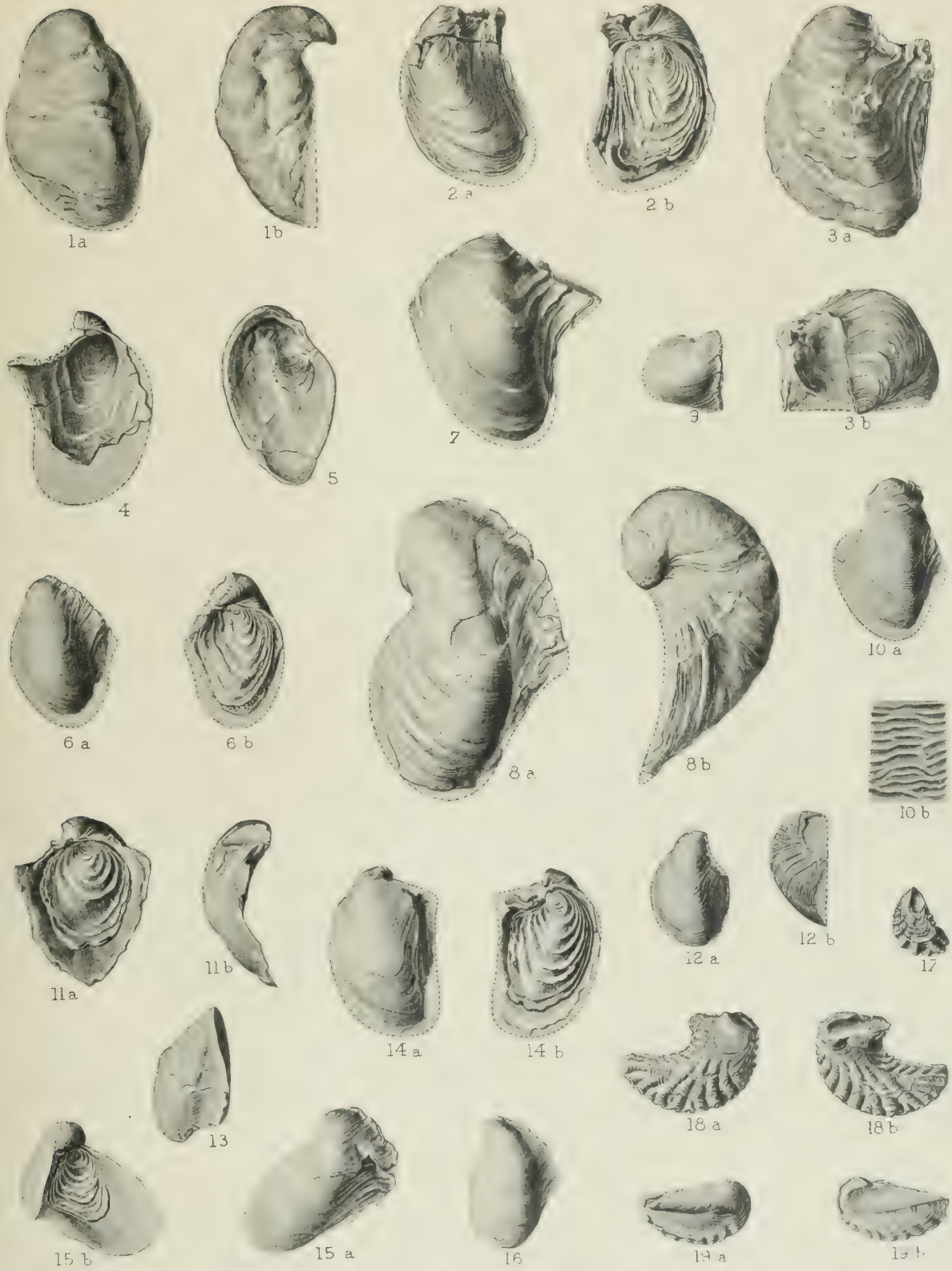

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PLATE LVII.

Ostrea (*continued*).

Figs.

1—13. *O. semiplana*, Sow. Upper Chalk. (P. 379.)

1—4. Zone of *Belemnitella mucronata*, Norwich. Norwich Museum. 1*a*, 2*a*, 3*a*, 4*a*, right valves. 1*b*, 2*b*, 3*b*, 4*b*, left valves.

5. *Uintacrinus* band, Thanet Coast. Dr. Rowe's Collection. *a*, left valve; *b*, interior of the same; *c*, right valve of the same specimen.

6. Zone of *Belemnitella mucronata*, Hartford Bridge, Norwich. Dr. Rowe's Collection. *a*, right valve; *b*, left valve.

7. Same zone, Norwich. Norwich Museum. *a*, left valve; *b*, interior of the same.

8, 9. *Uintacrinus* band, Thanet coast. Dr. Rowe's Collection. 8, 9*a*, right valves; 9*b*, left valve.

10—12. Zone of *Belemnitella mucronata*, Norwich. Sedgwick Museum, Cambridge. 10, 11*a*, 12, right valves; 11*b*, left valve; 12*b*, posterior view of 12*a*.

13. Same zone and locality. Norwich Museum, No. 2130. Right valve.

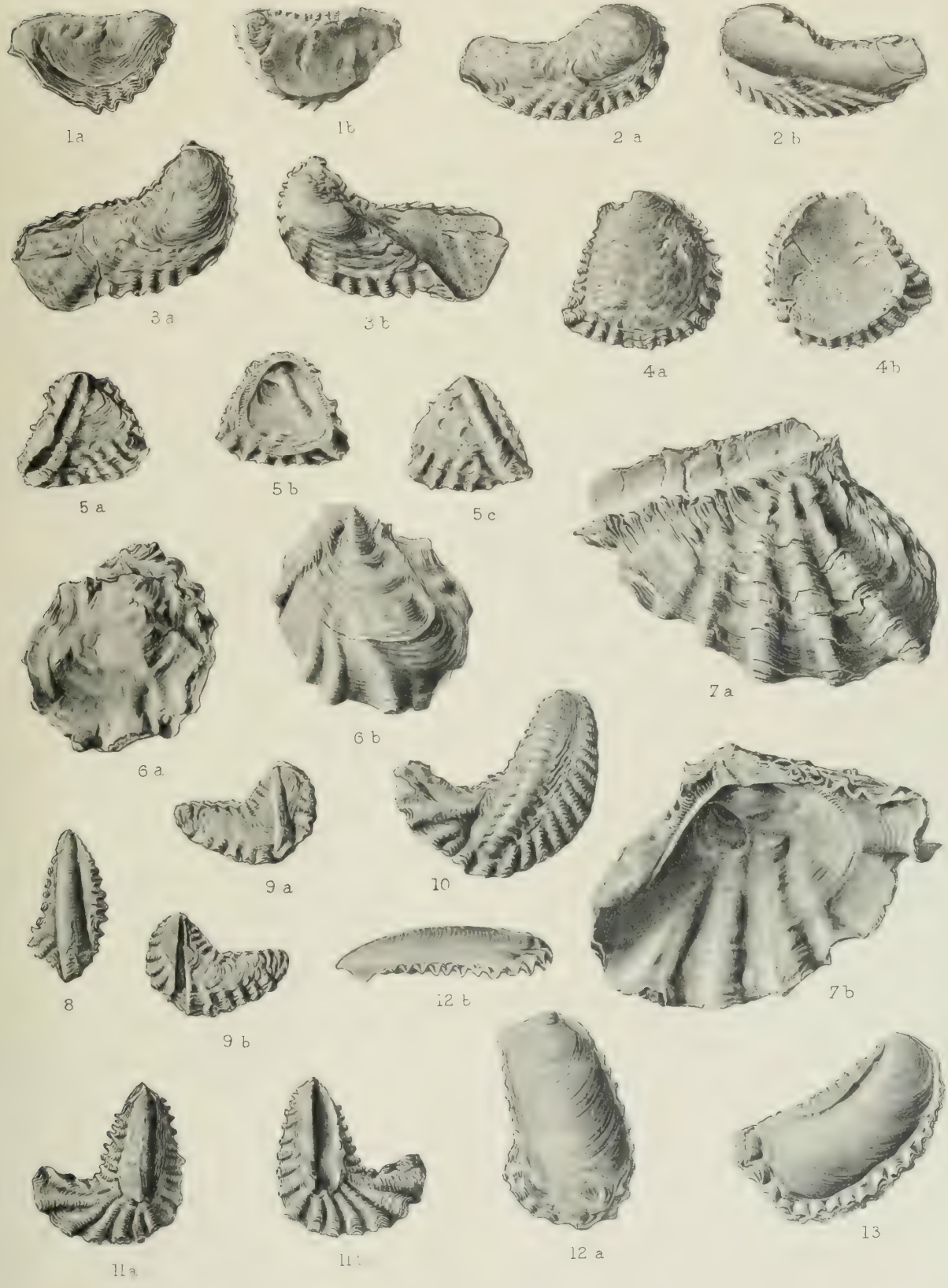

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PLATE LVIII.

Ostrea (*continued*).

Figs.

1—5. *O. semiplana*, Sow. Zone of *Belemnitella mucronata*, Norwich. (P. 379.)

1. Sedgwick Museum. *a*, right valve; *b*, anterior view.
2. Norwich Museum, No. 2129. *a*, right valve; *b*, left valve; *c*, anterior view.
3. Dr. Rowe's Collection. Right valve.
4. Norwich Museum. One of the types of *O. alæformis*, Woodward (pl. vi, fig. 3). *a*, right valve; *b*, interior.
5. Norwich Museum, No. 2085. Right valve.

6—9. *O. sarumensis*, Woods. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. 6, right valve; 7*a*, 9, left valves; 7*b*, posterior view of 7*a*; 8, right valve. (P. 387.)

10—13. *O. incurva*, Nilss. Right valves. (P. 388.)

10, 11. Totternhoe Stone (zone of *Holaster subglobosus*), Burwell. Sedgwick Museum.

12. Zone of *Terebratulina lata*, South Devon Coast. Dr. Rowe's Collection.

13. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection.

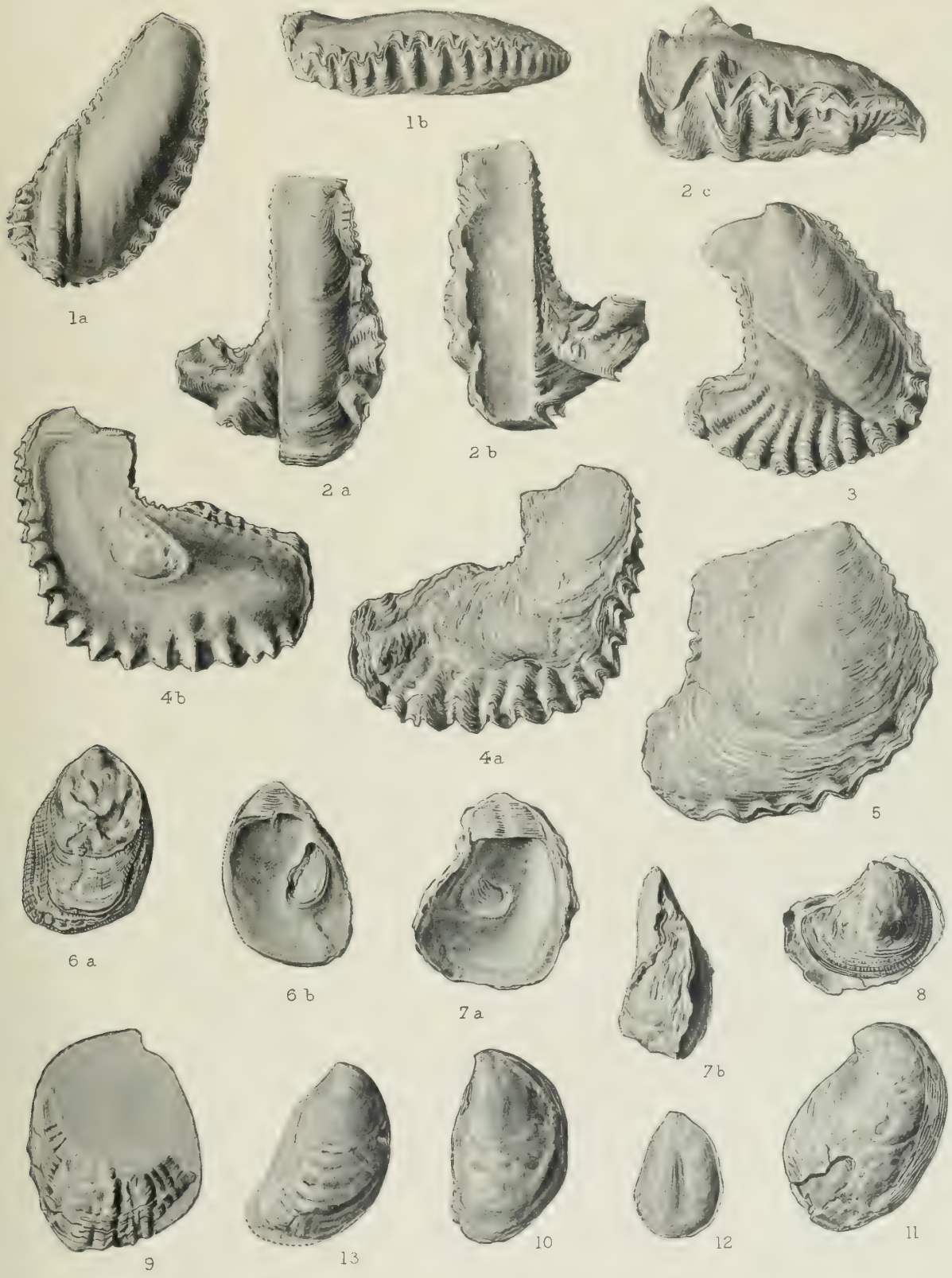

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PLATE LIX.

Ostrea (*continued*).

Figs.

1—16. *O. incurva*, Nilsson. Upper Chalk. Right valves, except 13*c*. (P. 388.)

1. Zone of *Micraster cor-anguinum*, Croydon. Sedgwick Museum.

2, 3. *Uintacrinus* band, Devizes Road, Salisbury. 2*b*, posterior view of 2*a*. Dr. Blackmore's Collection.

4, 5. Zone of *Actinocamax quadratus*, Whaddon. Dr. Blackmore's Collection.

6—11. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. 6*b*, posterior view of 6*a*.

12—16. Zone of *Belemnitella mucronata*, Norwich. 12, Museum of Practical Geology, No. 25983; the left valve is entirely attached to a slightly convex surface. 13, Dr. Rowe's Collection; 13*b*, interior of right valve 13*a*; 13*c*, area and hinge of left valve. 14, Norwich Museum. Type of *O. triangularis*, Woodward, pl. vi, fig. 7; 14*b*, posterior view showing portion of *Inoceramus* to which the left valve was entirely attached. 15, Norwich Museum; exterior and interior of a right valve. 16, Sedgwick Museum, Cambridge.

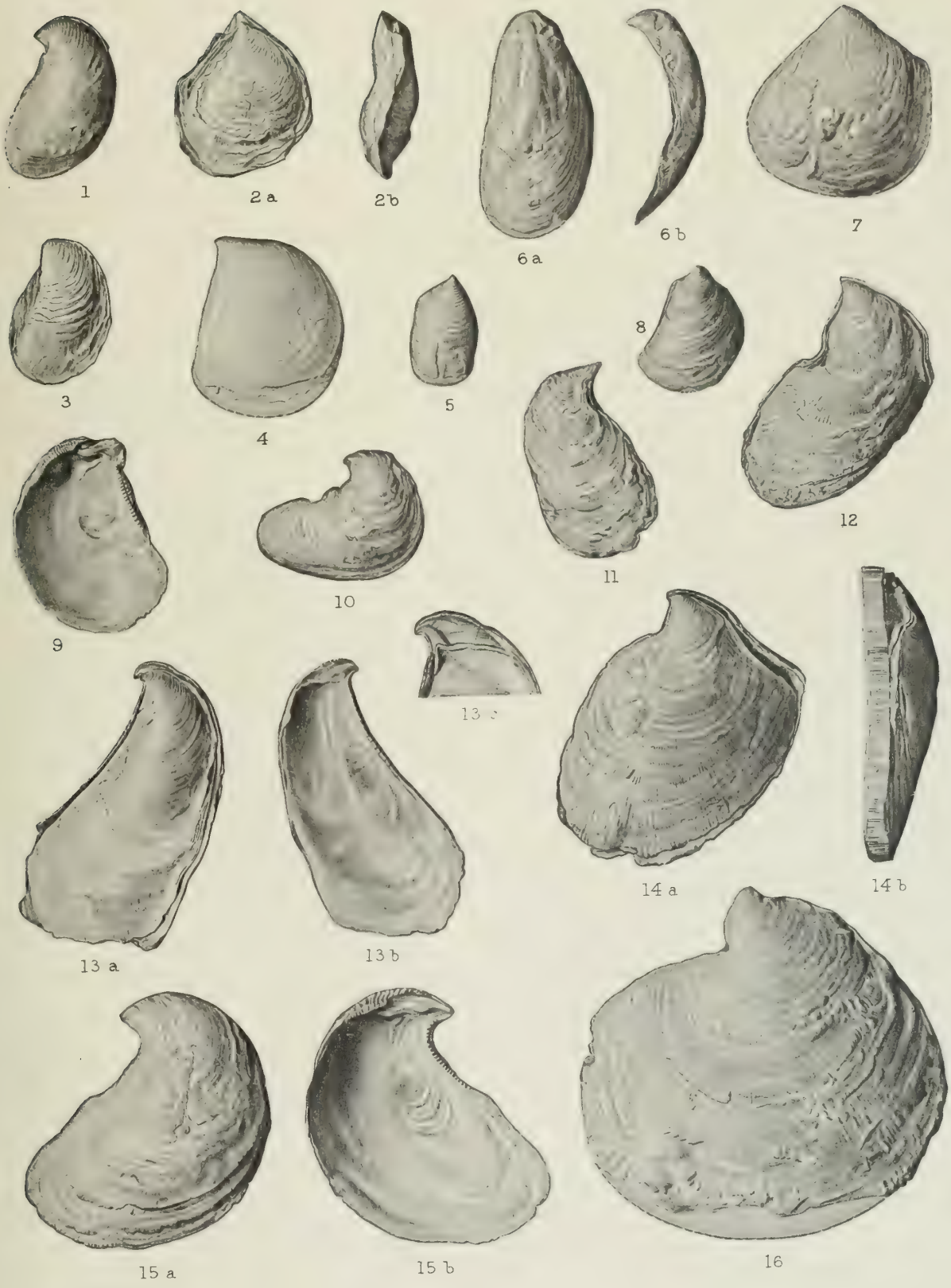

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PLATE LX.

Ostrea (*continued*).

Figs.

1—15. *O. Boucheroni*, Coq. Upper Chalk. (P. 391.)

1. Zone of *Actinocamax quadratus*, Wield. Mr. Brydone's Collection. Left valve. 1*b*, posterior view.

2–4. Zone of *Marsupites testudinarius*, Brighton. 2, 3, Brighton Museum. 4, British Museum, No. L 11795. Left valves. 3*b*, posterior view of 3*a*.

5. *Uintacrinus* band, Thanet coast. Dr. Rowe's Collection. *a*, left valve; *b*, right valve; *c*, anterior view.

6. Zone of *Marsupites testudinarius*, Brighton. Brighton Museum, *a*, left valve; *b*, posterior view; *c*, right valve.

7. Zone of *Micraster cor-anguinum*, Loam Pit Hill, Lewisham. Sedgwick Museum. Left valve.

8, 9. Zone of *Micraster cor-anguinum*, Gravesend. 8, Museum of Practical Geology, No. 25977. 9, Sedgwick Museum. Left valves; 8*b*, posterior view of 8*a*.

10—13. *Uintacrinus* band, Thanet coast. Dr. Rowe's Collection. 10*a*, right valve and margin of left valve; 10*b*, posterior view of 10*a*. 11, left valve with large surface of attachment; *b*, posterior view. 12, left valve. 13*a*, right valve; 13*b*, anterior view of both valves showing large surface of attachment.

14. Zone of *Micraster cor-anguinum*, Loam Pit Hill, Lewisham. Sedgwick Museum. Left valve.

15. *Uintacrinus* band, Devizes Road, Salisbury. Dr. Blackmore's Collection. Left valve. *b*, posterior view.

16—19. *O. lunata*, Nilss. Zone of *O. lunata*, Trimingham. Mr. R. M. Brydone's Collection. Left valves. (P. 393.)

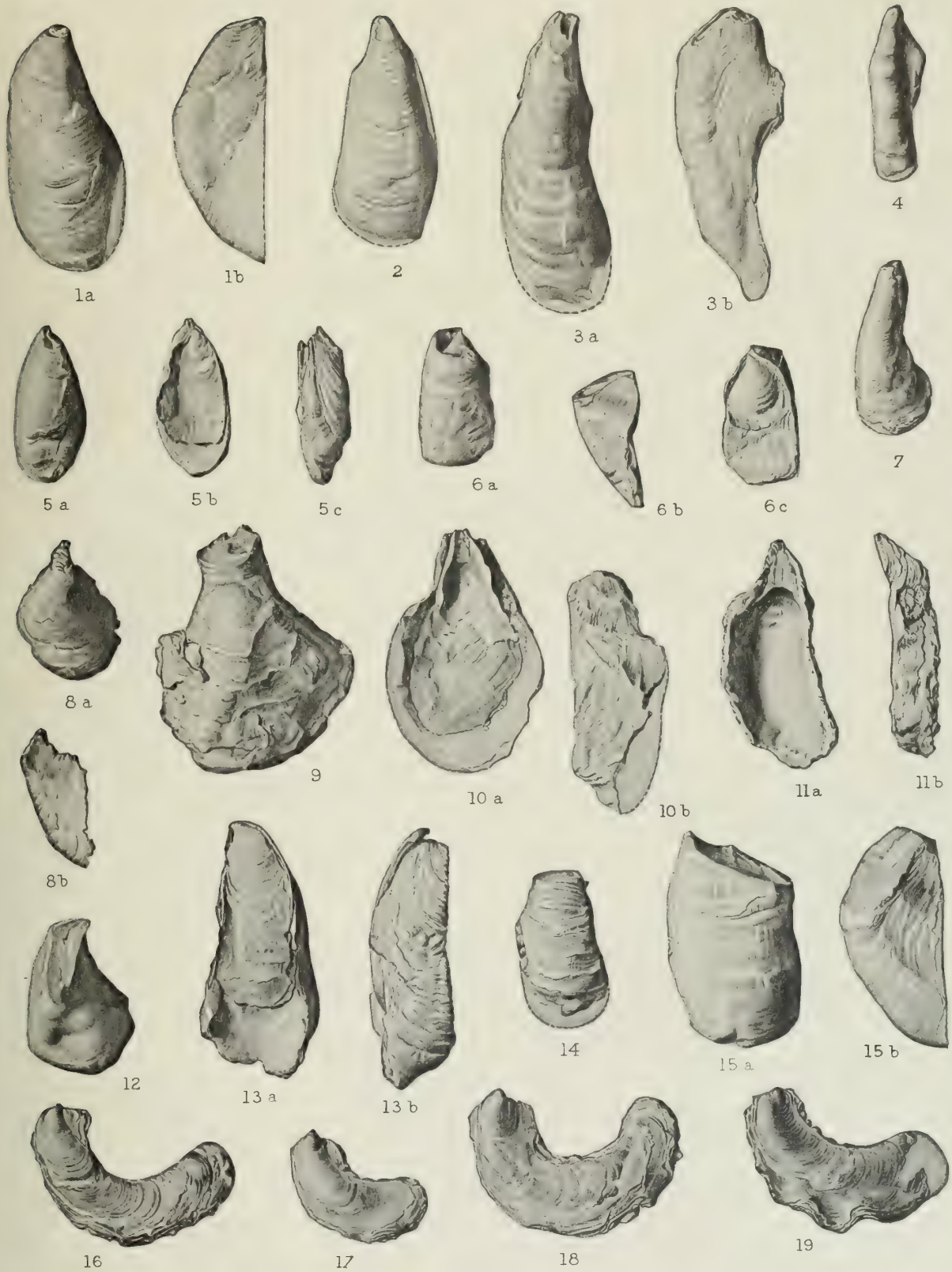

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PLATE LXI.

Ostrea (*continued*).

Figs.

1—6. *O. lunata*, Nilss. Zone of *O. lunata*, Trimingham. 1, 5, 6, Mr. R. M. Brydone's Collection. 2—4, Sedgwick Museum. 1*a*, 2—5*a*, 6*a*, left valves. 1*b*, right valve of 1*a*; 1*c*, anterior view of 1*a*. 5*b*, right valve of 5*a*. 6*b*, anterior view of 6*a*. (P. 393.)

Genus—Exogyra, *Say.*

7—11. *E. tuberculifera*, Koch and Dunk. Lower Greensand. (P. 404.)

7. Crackers, Atherfield. British Museum, No. L 6461. *a*, right valve; *b*, left valve.

8. *Perna*-bed, East Shalford. Sedgwick Museum. Left valve.

9—11. Hythe Beds, Lympne. Museum of Practical Geology, Nos. 25957, 25958, 25968. Left valves. 11*a*, interior of 11*b*.

12. *E. sigmoidea*, Reuss. Zone of *Micraster cor-anguinum*, Boxford. Mr. Ll. Treacher's Collection. Right valve. (P. 419.)

13. *E. sinuata* (Sow.). *Perna*-bed, Atherfield. British Museum, No. L 6306. Left valve. Variety of the *lævigata* form with ribs. (P. 395.)

Supplementary figures.

14—17. *Crenella orbicularis* (Sow.). Upper Greensand (zone of *Schlœnbachia rostrata*), Blackdown. Sedgwick Museum. 14, 16, right valves. 15, 17*a*, left valves. 17*b*, dorsal view of 17*a*. × 2. (P. 423.)

18. *Pecten* (*Chlamys*) *britannicus*, Woods. Zone of *Micraster cor-anguinum*, Bromley. Sedgwick Museum. *a*, right valve; *b*, portion above the middle of the valve × 5. (P. 424.)

19. *Lima* (*Limea ?*) sp. Speeton Clay, Speeton. Sedgwick Museum. *a*, right valve; *b*, portion × 6. (P. 425.)

20, 21. *Crassatellites ? equisulcatus* (Woods). Chalk Rock, Cuckhamsley. Sedgwick Museum. 20, left valve; 21, internal cast of right valve. (P. 426.)

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PLATE LXII.

Supplementary Figures.

FIGS.

1. *Crassatellites ? equisulcatus* (Woods). Chalk Rock, Cuckhamsley. Sedgwick Museum. Internal cast. *a*, right valve; *b*, dorsal view. (P. 426.)

2, 3. *Cyprina Meyeri*, Woods. *Perna*-bed, Sandown. 2, Sedgwick Museum. 2*a*, left valve; *b*, dorsal view; *c*, hinge. 3, Museum of Practical Geology, No. 16747. Right valve. (P. 427.)

4. *Cyprina ? vectiana* (Forb.). Lower Greensand (Crackers), Atherfield. Sedgwick Museum. *a*, left valve; *b*, dorsal view; *c*, portion × 4. (P. 427.)

5, 6. *Unicardium ? compressum*, Woods. Lower Greensand (Crackers), Atherfield. Sedgwick Museum. 5*a*, 6, left valves. 5*b*, dorsal view of 5*a*. (P. 428.)

7—9. *Unicardium ? Mailleanum* (d'Orb.). Base of Chalk (zone of *Schlœnbachia varians*). 7, Beaminster; Oxford Museum; right valve. 8, Cerne Abbas; Oxford Museum; left valve, internal cast. 9, Maiden Newton. Sedgwick Museum. *a*, left valve; *b*, dorsal view. (P. 428.)

10. *Tellina ? phaseolina* (Phill.). Speeton Clay, Speeton. York Museum. Perhaps the type. Internal cast. *a*, left valve; *b*, dorsal view. (P. 429.)

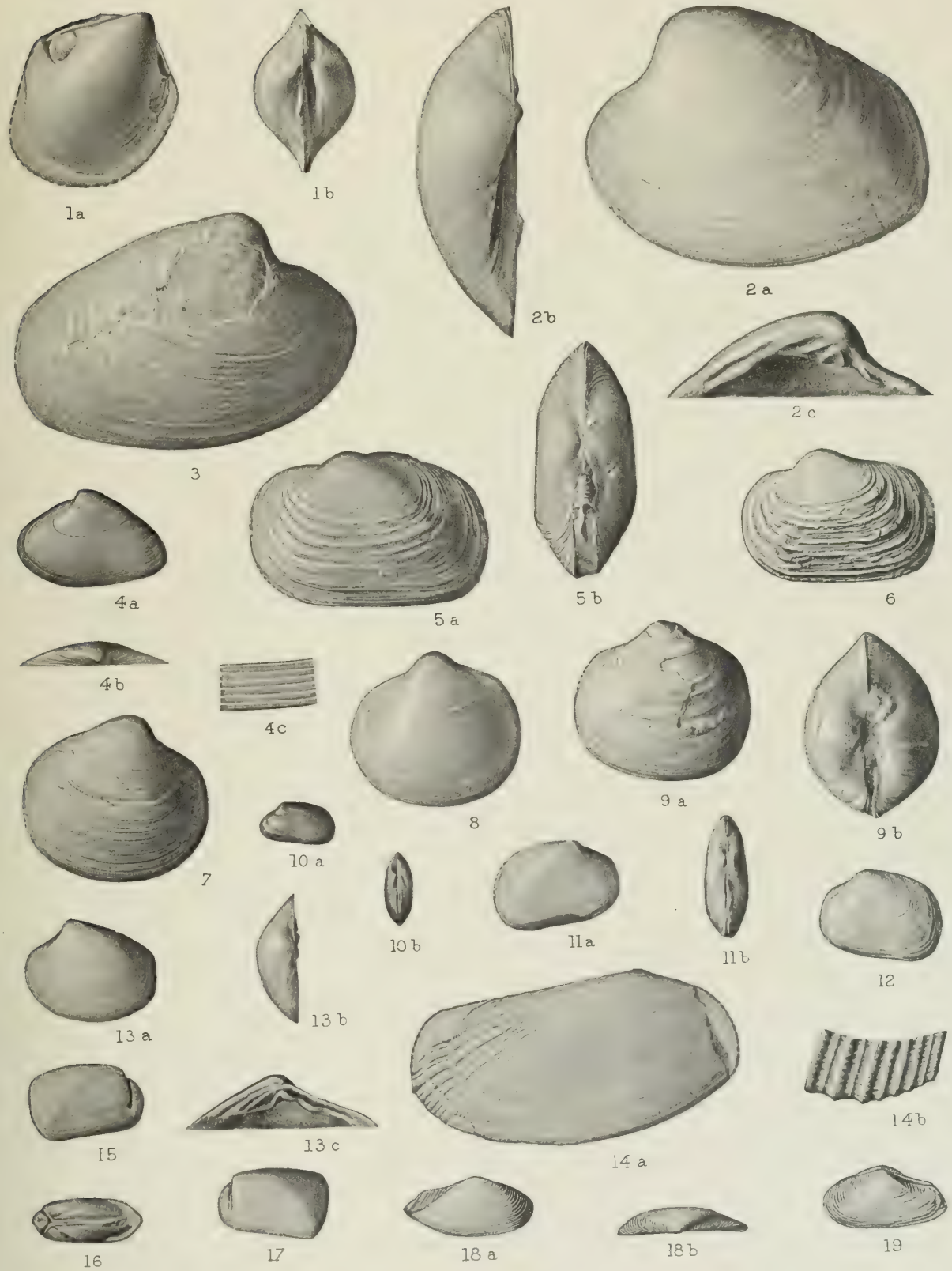
11, 12. *Tellina ? subphaseolina* (d'Orb.). Gault, Folkestone. 11, British Museum, No. L 4982; *a*, right valve; *b*, dorsal view. 12, Sedgwick Museum; left valve. × 1½. (P. 430.)

13. *Cyprimeria* (*Cyclorisma*) *submersa* (Sow.). Upper Greensand (zone of *Schlœnbachia rostrata*), Blackdown. Exeter Museum. *a*, left valve; *b*, dorsal view; *c*, hinge × 2. (P. 431.)

14. *Tapes* (*Icanotia*) sp. Upper Greensand (zone of *Schlœnbachia rostrata*). Blackdown. British Museum, No. L 17225. *a*, right valve; *b*, posterior part × 4. (P. 431.)

15—17. *Leptosolen ? rectangularis* (Woods). Chalk Rock, Cuckhamsley. Sedgwick Museum. Internal casts. 15, right valve. 16, dorsal view of both valves. 17, left valve. (P. 432.)

18, 19. *Thracia ? gracilis* (Sow.). Upper Greensand (zone of *Schlœnbachia rostrata*), Blackdown. Sedgwick Museum. 18*a*, right valve; 18*b*, dorsal view. 19, left valve. (P. 432.)



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OF

GREAT BRITAIN.

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BY

THOMAS BELL, F.R.S., F.G.S.

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